

# AQUATIC AND WILDLIFE RESOURCES



DEPARTMENT OF AGRICULTURE

OCTOBER 1, 1988 - SEPTEMBER 30, 1989  
FY 1989

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# **ANNUAL REPORT**

## **FISCAL YEAR 1989**

**GUAM**  
**DIVISION OF AQUATIC & WILDLIFE RESOURCES**  
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**DEPARTMENT OF AGRICULTURE**  
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**PERIOD COVERED:**  
**October 1, 1988 to September 30, 1989**





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The following persons were on the staff of the Division of Aquatic and Wildlife Resources sometime during the reporting period (October 1, 1988 to September 30, 1989):

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Rufo J. Lujan, Chief  
Robert D. Anderson, Assistant Chief  
Lillian L. Mariano, Public Information Officer

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The Division of Aquatic and Wildlife Resources, Department of Agriculture, wishes to acknowledge the following persons and organizations for their assistance in our work:

*Members of the Guam Fishing & Boating Association, the Marianas Fishing Derby Committee and the Manager of the Guam Fishermen's Coop for allowing fishery biologists to examine their fish;*

*Fishermen who have cooperated with fishery data collection;*

*Individuals who have donated Brown Tree snakes for research;*

*Individuals who have reported poaching activities and bird sightings;*

*Hunters who have cooperated with wildlife data collection by filling out and returning hunter questionnaires;*

*Base Commanders of the U.S. Naval Magazine, Naval Facility, Naval Station, Naval Communications Station and the Andersen Air Force Base;*

*Security Officers and their staffs at the U.S. Naval Magazine, Naval Station, Naval Communication Station, and Andersen Air Force Base;*

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*Print and electronic media for coverage of our programs and activities and for their support of conservation education programs;*

*Personnel of the Naval Oceanographic Command Detachment, U.S. Naval Air Station, Guam, for providing weather data;*

*The Marine Lab, University of Guam*



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**FEDERAL AID IN FISH AND WILDLIFE RESTORATION ACTS**

PROJECT NO. FW-2R-26  
FEDERAL AID IN FISH AND WILDLIFE RESTORATION ACTS  
JAN 1964

REPORT OF THE FEDERAL AID IN FISH AND WILDLIFE RESTORATION ACTS

PROJECT NO. FW-2R-26

JAN 1964

REPORT OF THE FEDERAL AID IN FISH AND WILDLIFE RESTORATION ACTS

**COORDINATION AND ADMINISTRATION  
PROJECT FW-2R-26  
(Federal Aid in Fish and Wildlife Restoration Acts)**

ADMINISTRATIVE AND FINANCIAL REPORT

PROJECT NO. FW-2R-26

REPORT OF THE FEDERAL AID IN FISH AND WILDLIFE RESTORATION ACTS

JAN 1964

The following is a summary of the administrative and financial report for the Federal Aid in Fish and Wildlife Restoration Acts, Project FW-2R-26, for the period January 1964. The report covers the period from January 1, 1964, to December 31, 1964. The project was administered by the Federal Bureau of Investigation, Department of Justice, and the Department of the Interior, Bureau of Land Management. The project was funded by the Federal Government and the State of California. The project was designed to provide for the restoration of fish and wildlife resources in the State of California. The project was carried out in accordance with the Federal Aid in Fish and Wildlife Restoration Acts, and the California Fish and Game Code. The project was completed on December 31, 1964. The project was successful in providing for the restoration of fish and wildlife resources in the State of California. The project was carried out in accordance with the Federal Aid in Fish and Wildlife Restoration Acts, and the California Fish and Game Code. The project was completed on December 31, 1964. The project was successful in providing for the restoration of fish and wildlife resources in the State of California.

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## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** C-1

**JOB NO.:** 1

**JOB TITLE:** Coordination of Guam's Fish and Wildlife Programs.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **OBJECTIVES**

To plan, coordinate, supervise, and administer all fish and wildlife restoration programs.

### **PROCEDURES**

1. Supervise the planning and documentation of the Fish and Wildlife programs.
2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.
3. Administer all personnel matters including recruitment of off-island staff.
4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

### **RESULTS**

The Division experienced several staff changes during the year. The former Division Chief, Harry T. Kami, retired in early October, 1988. The Assistant Chief, Robert D. Anderson, served as Acting Chief until the vacant Chief position was filled by Rufo J. Lujan in mid-May, 1989. Conservation Officers Domingo Pangilinan and Jimmy Camacho and Fishery Biologist Rebecca Hensley joined the staff. Paul Conry was promoted to Wildlife Biologist IV.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY '88 under its various federal programs and submitted them to the U.S. Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY '90. This documentation included a new Application for Federal Assistance for the Guam Fish and Wildlife Investigations project for the next five year period, as well as annual Project Agreements for the various Endangered Species Investigations and Fisheries Development projects that the Division conducts. These project documents received federal approval during the reporting period.



Fiscal and budgetary activities included monthly preparation and submission of reimbursement vouchers for our various Federal Aid programs and coordination with the Government Accounting and Budget Offices to ensure fiscal integrity.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military.

Considerable effort was also invested into preparing submittals for the Department's oversight hearings before the Committee on Economic Development at the 20th Guam Legislature, and for the Department's FY '89 budget hearing before the Committee on Ways and Means. A five-year budget plan that proposes a significant increase in the level of local funding for the Division's programs was also prepared and submitted to the Bureau of Budget and Management Research.

The Division organized a conference on the brown tree snake that was planned to include representatives from a number of island governments, the federal government, and a number of Government of Guam agencies. This conference was cancelled at the last minute at the request of the Department of Interior, who preferred that the conference wait until a planned inter-agency agreement regarding the brown tree snake problem is signed. Because the major researchers into the brown tree snake were already committed to being on Guam at the same time, an extremely productive research meeting was held by the researchers in lieu of the more general conference that had been planned. The general conference is still planned for some future time when the inter-agency agreement is successfully negotiated and signed. The Division has reviewed and contributed comments and suggestions regarding the draft inter-agency agreement.

Several training opportunities were made available to Division staff including a dredging workshop sponsored by the Army Corps of Engineers that was attended by Gerry Davis, a workshop on EA/EIS preparation and review sponsored by GEPA that was attended by Paul Conry and Gerry Davis, the U.S. Coast Guard Auxiliaries 12-lesson course entitled Boating Skills and Seamanship which was attended by most of the Division's fisheries, wildlife, and law enforcement staff, and a two-day course on Community Cardio-Pulmonary Resuscitation. Conservation Officers John Villagomez and Wayne Bigler attended a two-week course in "Covert Wildlife Investigation" sponsored by the U.S. Fish and Wildlife Service and a workshop on drug enforcement sponsored by the Guam Police Department was attended by Michael Reyes.

The Chief served on the Department's Land Lease Approving Committee, which must review and approve all proposed leases of government land for agricultural purposes. The Chief also served as the Government of Guam's representative to the Western Pacific Regional Fisheries Management Council.

Division staff made a number of off-island trips related to Federal Aid programs. Acting Chief Robert D. Anderson attended the annual Federal Aid Coordinators Conference, which was held in Couer d'Alene, Idaho, in early October.

Wildlife Biologist Mike Ritter travelled to Rota in December, 1988 and again in August to participate in a survey of forest birds being conducted jointly by the U.S. Fish and Wildlife Service and the CNMI Division of Fish and Wildlife for the U.S. Department of Agriculture.

Robert Beck traveled to Rota in March and April, accompanied by Gary Michael, Curator of Birds at the Louisville Kentucky Zoo, to survey Mariana crow populations and develop

capture techniques. While on Rota, they met with various officials of the Commonwealth of the Northern Mariana Islands and Rota municipal governments. Beck returned to Rota Municipal in August with Dr. Stuart Pimm, Professor of Zoology at the University of Tennessee and his graduate student, Gregory Witterman to introduce Greg to the Mayor and other officials on Rota, to assist him in getting settled on the island, and to do additional on-site planning for the introduction of rails to Rota.

Division Chief Rufo J. Lujan attended: a symposium on Indian fisheries in Seattle, Washington in early July; the Western Pacific Regional Fisheries Management Council which met in Hawaii at the end of July; and the 7th Annual CZM Conference in Honolulu at the end of August.

Wildlife Biologist Gary Wiles travelled to Rota in early November, 1988 to participate in a survey of the Marianas fruit bat population on the island that was being conducted by the CNMI Division of Fish and Wildlife. He also attended the 8th International Bat Research Conference held in Sidney, Australia in July, 1989.

Assistant Division Chief Bob Anderson, accompanied by Wildlife Biologists Paul Conry, Gary Wiles, Bob Beck, Mike McCoid, and Mike Ritter, plus Public Information Officer Lillian Mariano, traveled to Saipan in June to participate in a joint wildlife workshop hosted by the Wildlife Section of the CNMI Division of Fish and Wildlife. In June, the Fisheries Section of our DAWR hosted a similar Fisheries workshop on Guam that was attended by the Fisheries staff from the CNMI Division of Fish and Wildlife.

The Division hosted a number of off-island visitors during the year. Al Marmelstein, Ernie Kosaka, John Ford, Tom Fritts, Robert Reynolds, and Gordon Rodda, all of the U.S. Fish and Wildlife Service; John Naughton, Dave Hamm, Gene Witham and Bobby Shibazaki of the National Marine Fisheries Service; Carolyn Imamura of the Pacific Basin Development Council; Gary Michael, Curator of Birds at the Louisville Kentucky Zoo; Dr. Stuart Pimm, Professor of Zoology at University and his graduate student, Gregory Witterman; Lindsay Phillips, Veterinarian at the National Zoo; Dixie Pierson and Bill Rainey of the Museum of Vertebrate Zoology at the University of California at Berkeley; Manuel Santana, graduate student at the University of Arizona; David Chiszar of the University of Colorado; and John Groves, Curator of Birds at the Philadelphia Zoo all visited the division at various times and for various lengths of stay.

Numerous representatives of the CNMI Department of Natural Resources, including Biologists Phil Glass, Jim Reichal, Clifford Rice, Terry Donaldson, Cal Falig, David Aldan, Dave Hamm, and Stan Taisacan, visited during the year to discuss subjects of mutual interest.

Report prepared by: Robert D. Anderson

## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** C-2

**JOB NO.:** 1

**PROJECT TITLE:** Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

**JOB TITLE:** Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **BACKGROUND**

The Division's professional staff devoted a significant percentage of their time and effort to technical assistance. The rapid pace of development on the island is requiring increasing amounts of time from the Division's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. The Division's participation in the SDRC/TPC review process included a number of large new developments, such as the Miyama Hills complex, Huchunao Golf Course, Lake Agat Golf Course, Talofofo Golf Course, Marbo Cave Resort, DanDan Estates, Guam First Green Golf Course, Agana Boat Basin, and the Taotao Resort, among others. Because of the size and complexity of some of these developments, the Division's review responsibility will require a continuing commitment that could extend even beyond project completion.

### **OBJECTIVES**

1. To minimize adverse impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.
2. Provide technical assistance to military and civil agencies relative to the management and protection of fish and wildlife resources.

### **FINDINGS**

The staff of the Division has been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.



Various Division staff members actively serve as members of the following groups:

1. Ad Hoc Fisheries Council
2. Region IX Regional Response Team - Oceania
3. Brown Tree Snake Task Force
4. Subdivision and Development Review Committee
5. Agricultural Lease Approving Committee
6. Fish and Wildlife Conservation Committee- Andersen Air Force Base
7. Water Use Master Plan Task Force
8. Western Pacific Regional Fisheries Management Council
9. Western Pacific Regional Pelagic Plan Monitoring Team
10. Western Pacific Regional Bottomfish Plan Monitoring Team
11. Exotic Species Importation Review Panel
12. Bird Aircraft Strike Hazard Committee - Andersen Air Force Base

Members of the Division have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, U.S. Army Corps of Engineers (ACOE), the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the U.S. Navy, the U.S. Coast Guard, the U.S. Air Force regarding matters of environmental and the concern. In addition, staff members actively consulted with numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Division staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspaper, staff members participated in National Wildlife Week, Chamorro Week, Earth Week and Environmental Fair activities and gave talks to a number of civic groups, sportsman clubs, and school and university classes.

Some specific Technical Assistance activities included:

1. The Division was represented on the Subdivision and Development Review Committee, which met bi-weekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is very important in ensuring that the protection of Guam's fish and wildlife resources is considered in land use planning.
2. The Division's participation in the SDRC/TPC review process included various phases of a number of large new developments, such as the Miyama Hills complex, Huchunao Golf Course, Lake Agat Golf Course, Talofoto Golf Course, Marbo Cave Resort, DanDan Estates, Guam First Green Golf

Course, and the Taotao Resort, among others. The Taotao Resort project, in particular, required a great deal of time and effort on the part of Division staff, as there were numerous meetings and hearings held on this project. Because of the size and complexity of some of these developments, the Division's review responsibility will require a continuing commitment that could extend even beyond project completion.

3. The Division has also been heavily involved in reviewing and responding to the Navy's Relocatable Over-the-Horizon Radar (ROTHR) installations that are currently planned for the Northwest Field (NWF) area. The EIS for this project was completed by the Navy and circulated for review and comment. The Division reviewed this document in detail and submitted comments that encouraged the Navy to further explore the feasibility of alternative sites for the ROTHR project. A series of public hearings were held on this project and these were attended by Division staff. The Division also provided review and consultation for military agencies on a number of smaller proposed developments and activities.
4. The Division prepared plans to designate critical habitat for endangered species on Guam, and to both the local and Federal Government. The proposal to designate critical habitat for endangered species on Guam required a considerable amount of effort on the part of the Division staff. The U.S. Fish and Wildlife Service has officially proposed to designate critical habitat in both northern and southern Guam for the endangered native birds and fruit bats, but the boundaries that they proposed were chosen for their ease of mapping and consequently included considerable land area that does not have critical habitat value. Division staff prepared an alternative map of proposed critical habitat that more closely reflects the true area required for the restoration and recovery of Guam's endangered species. The Division also provided briefing papers and other information regarding critical habitat to the Governor's office.
5. The Division also reviewed and commented upon a number of dredging and wetland developments including the Agaña Bay Front Storm Surge Protection Plan, Sunset Beach Hotel dredging, the development of a wetland enhancement plan as mitigation for the Talofofu River fish ponds, a similar mitigation plan for the aquaculture operation on the Agfayan River, the expansion of an access road through the Pago Bay wetland, an industrial park proposed for the Atantano River wetland, a landing craft ramp on Cocos Island, and an expanded container yard at Commercial Port.
6. The Division completed a proposal to establish a Marine Conservation Area in Tumon Bay and circulated it to other government departments for preliminary review.
7. A comprehensive proposal for the designation of Government of Guam land, including some submerged lands, for conservation was prepared and submitted to the Department of Land Management, Parks & Recreation and Bureau of Planning for review.
8. The Division participated in the Water Use Master Plan Task Force chaired by the Bureau of Planning. The plan phase required submittal of area specific fisheries data, aquatic habitat resources information and public interest to the Bureau of Planning. This committee developed a plan to

control marine water (fishing, jet skis, wind surfers, boats, etc.) uses between East Agana and the USO in Piti. Division staff attended a series of public hearings sponsored by the Bureau of Planning regarding the proposed Water Use Master Plan.

9. Division staff spent considerable time assessing the environmental impacts of the Ugum River Project sponsored by Public Utility Agency of Guam (PUAG) and submitted comment to the Bureau of Planning.
10. The Division also responded to numerous requests for information regarding identification of specific aquaculture discharge permit problems, bird and mammal mortality caused by pesticides, wildlife rehabilitation on Guam, importation of wildlife and endangered species, hunting and fishing regulations etc.
11. The Division's staff contacted and met with military officials and provided comment to the US Navy, Army Reserve and US Air Force regarding the helicopter training exercises in Northwest Field (NWF) and their impacts on nesting crows and other endangered species in the area.
12. The Division participated in a site inspection and provided consultation on the impacts on endangered wildlife during proposed Army National Guard, and Andersen Air Force Base Security Police Squadron training exercises at Andersen Air Force Base.
13. The Division prepared comments on the impacts on resources and associated wildlife concerning the installation of a navigation light system at Andersen Air Force Base for the Space Shuttle.
14. The Division reviewed and submitted comments to Guam Environmental Protection on the Navy's proposed pipeline pigging operation from Fena to the Barrigada Reservoir.
15. The Division provided technical assistance to Andersen Air Force Base regarding the problem of reducing deer populations to optimum levels. This assistance included providing information, technical advice and special either-sex control hunts.
16. The Division reviewed and commented on several legislative bills that would affect fish and wildlife resources.
17. The Division reviewed and commented on several ACOE permit applications to place buoys at several locations in East Agana Bay and Cocos Lagoon to provide an area for the commercial operation of mechanized aquatic recreational vehicles such as jet skis.
18. The Division assisted in the preparation of several Agricultural Impact Statements which are required in cases involving the rezoning of lands zoned "A" (Agricultural). In cases where the proposed rezoning would have negative impacts on the conservation of wildlife resources, recommendations were made to disapprove the proposed rezoning.



19. The Division reviewed and commented on several proposals to dispose of government land through sale or exchange and made appropriate recommendations for the conservation of wildlife resources.
20. The Division reviewed and submitted comments to the ACOE and Bureau of Planning regarding channel dredging and impacts to mangroves in Achang Bay Marina.
21. Division staff provided annual announcements of seasonal area closures for the harvest of fish and monitored posted areas during appropriate time periods.
22. The Division reviewed and commented on the Guam Environmental Protection Agency on their Safe Drinking Water Plan.
23. The Division provided comments to the Attorney General concerning impacts to resources with respect to underwater offshore salvage operations.
24. The Division investigated several reports of suspected fish kills in island waters during the year.
25. The Division responded to many requests for information on laws and regulations pertaining to fish, wildlife, native and endangered species, hunting and fishing and importation of wildlife.
26. The Division responded to many requests for information on native wildlife, particularly endangered species.
27. Division staff maintained contact with the Customs and Quarantine Division to discuss animal imports and endangered species questions.
28. The Division Chief served as the Department's Response Activity Coordinator with Civil Defense.
29. A member of the Division staff made a presentation on oil spill hazards and sensitive areas at a meeting of the Regional Response Team.
30. The Division provided information to the Department of Commerce on Guam's annual fisheries harvest and harvest estimates to the Guam Visitors Bureau for the Guam International Fishing Derby.
31. The Division provided information on numerous occasions on aspects of the proposed rail introduction to both on and off-island individuals and agencies.
32. The Division provided information and technical recommendations to the Attorney General's office regarding needed revisions to the regulations regarding fish weir permits and attending meetings to discuss proposed alterations.
33. The Division reviewed and commented on the latest version of the ACOE Agana River Flood Control Plan and attended meetings to review the supplemental EIS.

34. Division staff provided reports to National Marine Fisheries Service on turtle tagging and releases, and a report of a dead whale which washed ashore.
35. The Division submitted a listing of local species of fish which have been associated with ciguatera poisoning to the Food and Drug Administration.
36. The Division reviewed and commented to the Guam Environmental Protection Agency on proposed phase I dredging plans in Apra Harbor to dredge and clear underwater debris adjacent to Port Authority facilities.
37. Division staff provided technical assistance to numerous farmers and the Air Force and the Navy regarding pig damage. Damage control permits were issued when warranted.
38. Several Division staff reviewed manuscripts for other authors and for professional journals.
39. The Division provided technical assistance to the South Pacific Commission by reviewing annual work plans providing information on fishing activity, and reviewing a Tuna/Billfish assessment.
40. The Division provided information to the South Pacific Commission regarding Guam's commercial and subsistence fisheries.
41. The Division provided technical assistance to the Attorney General's Office in identifying fish killed illegally with explosives, hair and other tissues from suspected deer and pig carcasses, and in interpreting the laws and regulations that apply to fish and wildlife resources.
42. Division staff attended hunter safety briefings at Andersen Air Force Base to provide pertinent information to hunters.
43. Division staff made presentations on fish and wildlife resources at meetings of numerous clubs and other organizations during the year.
44. Division staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting seasons, laws and regulations, endangered species, fish and wildlife importation, etc.
45. Technical assistance was provided to the Marianas Fishing Derby.
46. Technical information on the state of Guam's fish and wildlife resources was provided to the Guam Environmental Protection Agency for their annual report.
47. Technical assistance and logistical support was given to Drs. Thomas Fritts and Gordon Rodda of the U.S. Fish and Wildlife Service, each of whom spent time on Guam consulting with Division staff on the brown tree snake.
48. The Division reviewed and commented on the proposed Andersen Air Force Base Hunting Regulations and worked closely with their staff in planning special either-sex control hunts for deer.

49. The Division reviewed and commented to the ACOE on the impacts of constructing applications for two piers and a boat launching ramp in Cabras Lagoon to serve two tour companies conducting dinner cruises and charter trips.
50. The Division reviewed and commented on the impacts on the proposed relocation and construction plans for the Marianas Yacht Club for Port Authority property on Dry Dock Point.
51. The Division reviewed and commented on the scope of work proposed in an environmental baseline survey for coastal property in the lower reaches of Talofofo River.
52. The Division reviewed and commented on the 60% submittal plans for reconstruction of Rt. 3 proposed by PWC.
53. The Division's Fisheries staff identified fish species which were suspected in illegal harvest incidents to the Division's Conservation Officers.
54. The Division responded to an EIS survey on the Dingell-Johnson program.
55. A Division staff member assisted the Commonwealth of the Northern Mariana Islands Fish and Wildlife Division in conducting surveys of Mariana fruit bats on the island of Rota.
56. A member of the Division staff participated as a member of the IUCN Species Survival Commission for fruit bats, provided information on the trade in fruit bats, and reviewed and commented on a CITES proposal to extend CITES protection to Pacific Island fruit bats
57. The Division reviewed and commented on the ACOE Agana Bay Typhoon Storm Surge Protection Plan and attended meetings to discuss problems with the proposed plans.
58. The Division provided quarterly fisheries data collection reports to National Marine Fisheries through disk data files and assisted in the preparation and review of the annual bottomfish and pelagic fisheries reports to the Western Pacific Regional Fisheries Management Council.
59. A member of the Division staff made several presentations regarding the brown tree snake at training classes conducted by military customs.
60. A member of the Division staff made a presentation on the brown tree snake at a conference of terminal and stevedore operators of Micronesia.

Report prepared by: Gerald Davis



## JOB PROGRESS REPORT INFORMATION/EDUCATION PROGRAM

STATE: Territory of Guam

PROJECT NO.: FW-2R-26  
SUB-PROJECT NO.: C-3  
JOB NO.: 1

**JOB TITLE:** Public Information and Education of Guam's Fish and Wildlife Restoration and Endangered Species Programs.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### SUMMARY

The Division of Aquatic and Wildlife Resources' (DAWR) Public Awareness and Conservation Education Program (PACE) continues to inform and educate the local community on the need to manage, protect and conserve Guam's resources, a program that was reactivated in March 1988 with the recruitment of a Public Information Officer.

Development and revision of conservation education and information materials on fish and wildlife and endangered species, begun in FY '88, were completed during FY '89. However, only the Fish and Wildlife Coloring Books and Activity Guides were printed. In the school visitation program, 65 classes or approximately 1,500 students were visited, 95% of which were K-5 students, with the remaining 5% comprised of middle school students in grade levels 6 through 9.

The planned February, 1989 arrival of an Aquatic/Hunter Education Training Specialist from Region I to assist the Division in developing its Aquatic and Hunter Education programs, did not materialize. In late September, 1989, the Division was advised that the training specialist would be arriving on Guam in early November, 1989. Although the Division does have a preliminary plan of action for the implementation of Aquatic and Hunter Education programs, it would be to DAWR's advantage to consult with the specialist to ensure that program requirements are met.

### BACKGROUND

The Division's Public Awareness and Conservation Education (PACE) Program was reactivated in March 1988 with the recruitment of a Public Information Officer (PIO). The PACE program was originally funded by a grant from the Coastal Zone Management Program under the Government of Guam's Bureau of Planning (BOP), however, a reduction in overall funding levels prevented the BOP from renewing the CZM grant to the Division in 1983. Funding uncertainties precluded the Division from actively continuing the program until March 1988.

Efforts have focused on rekindling public awareness, appreciation and concern for Guam's endangered species and fish and wildlife resources, strengthening the local community's conservation ethics and reinforcing the importance and value of conserving and preserving a vital part of Guam's natural history. Success can perhaps best be measured by the community's positive response to the Division's programs and activities. Residents

continue to respond to calls for snake specimens, report poaching activities (although anonymity is frequently requested), bring in birds presumed to be endangered species, and encourage the Division to institute more intensive management programs for Guam's fish and wildlife resources. The latter can perhaps best be attributed to the rapid growth and development of an island only 36 miles long, whose limited resources are being tapped by an increasing and culturally-diverse population.

## PROCEDURES AND RESULTS

To date, activities and efforts include:

1. Completion of the layout for flyers on 48 of Guam's vertebrates and invertebrates, to be distributed to elementary, middle and secondary students. Each flyer, which will be printed in full color, will identify each species by its common and scientific names, briefly explain the animal's behavioral and feeding habits, its reproductive potential, and current status. These materials will serve as a source of reference for students of all grade levels, and would enable them to learn about Guam's extinct or endangered species, as well as the more common animals found on Guam. Printing cost, which is estimated at approximately \$14,000, may be partially, if not entirely, absorbed by the CZM program at the BOP.
2. Coordination and development of cooperative poster projects with the Commonwealth of the Northern Marianas (CNMI). The posters include: (a) Forest and Land Birds of the Marianas; (b) Seabirds, Shorebirds, and Waterbirds of the Marianas; and (c) Common Fishes of the Marianas.
3. Production of 24 (twenty-four) Public Service Announcements (PSAs) focusing on fish and game conservation, impacts of illegal hunting and fishing, coral reef preservation, poisonous sea animals, endangered species, fish and wildlife habitats and the adverse impact of brown tree snakes on native forest birds as well as humans. Production cost, (the scripts were written in-house) totalled \$4,000 and target date for completion is December 31, 1989. The PSAs will be aired free of charge on KGTF (Guam's public television station), KUAM TV Channel 10 and on KTGM TV 14. Since most of the PSAs are adaptable for radio as well, efforts are being made to secure free air time on KUAM 610 Radio AM, Classic 94 FM, K-57 AM, Z-98 FM, K-Stereo, and Hit Radio 100 FM.
4. Completion of an information pamphlet on the Brown Tree Snake. Printing of the pamphlet, estimated at \$2,000 for 5,000 copies, was not completed during the reporting period due to lack of funding. Again, CZM may possibly absorb some, if not all, printing costs.
5. Development of bumper stickers on (1) the endangered Marianas Fruit Bat, and (2) fish and wildlife conservation in general. Printing cost for 5,000 fruit bat or conservation stickers is estimated at \$3,000.
6. Publication of a feature article on the impacts of illegal fishing, press releases on the Division's programs and activities, and the initiation of a bi-weekly column in the Guam Tribune newspaper entitled "Let's Talk Fish and Wildlife". Written by Division staff, the column features articles on the Division's research programs and activities, fish and wildlife laws and regulations, endangered species, habitat protection and other related topics. Contributing writers consist

of Division staff. Articles are also submitted regularly to CZM's Man, Land and Sea newsletter, a monthly publication distributed to government offices and major supermarkets.

7. Participation of Division staff on live radio and television talk shows including:
  - (a) a two-hour simulcast on Station KUAM's "Programman Chamorro," during which Division Chief Rufo J. Lujan, Officer-in-Charge of the Division's Enforcement Section, Lieutenant John S. Villagomez, and the PIO fielded questions from the public concerning fishing and hunting regulations, management of Guam's fisheries in terms of size limits, seasons and harvesting methods, protection of fish and wildlife habitat and other related topics. A return appearance is scheduled sometime within FY '90;
  - (b) a two-hour appearance on Radio Station K-57's Jon Anderson Show by Division's Acting Chief Robert D. Anderson and Division's Herpetologist Michael J. McCoid. The topic of discussion was the impact of brown tree snakes on Guam's endangered and wildlife species, the human population, and the efforts being made to address the problem; and
  - (c) a one half-hour appearance on Radio Station K-57 by Division Wildlife Biologist Robert Beck, and Dr. Scott Derrickson, Curator of Birds at the the Conservation and Research Center of the Smithsonian Institution. The captive breeding programs for the Guam Rail and Micronesian Kingfisher, and the planned release of an experimental population of Guam Rails on Rota were discussed with talk show host Jon Anderson.
8. Continuation of library and school visits, primarily elementary and middle schools. In order to give students the opportunity to meet and thereby develop a respect for conservation officers and the role they play in the management and enforcement of Guam's endangered species, and fishing/hunting laws and regulations, the school presentation format now includes the presence and involvement of one or two Conservation Officers. The wildlife segment consists of a slide show on endangered species and game management, while the fish segment consists of a 25-minute video tape on coral reef ecology. Presentations are complemented by a display of live and preserved animals, followed by a question-and-answer period.
9. Maintenance and public exhibit of the live brown tree snake display and information board. The display was viewed at the University of Guam's Bilingual-Bicultural Science and Math Educational Conference for the Micronesia Region, the Earth Week observance at the Micronesian Mall, the observance of Port Authority of Guam Week, and the anniversary celebration of the War in the Pacific National Historical Park.
10. Development of an information board highlighting the impact of poaching on endangered species and fish and wildlife resources. The display was first exhibited during the Guam Police Department's annual observance of Police Week. It was also on display for a month at the War in the Pacific National Historical Park. An estimated 5,000 schoolchildren and adults have viewed this display.



11. Development of a preliminary plan of action for the implementation of an aquatic/hunter education program.

## **RECOMMENDATIONS.**

1. Continue fish and wildlife presentations at libraries and schools, both public and private.
2. Continue public awareness program through press releases, published articles, and other media to keep public informed of the progress and accomplishments of the Division's various fish, wildlife and endangered species programs.
3. Secure funding sources for printing of pending conservation education/information materials, and develop other curriculum materials.
4. Coordinate the Division's participation in mutual programs and projects with Guam's Department of Education, CZM, Sea Grant, the University of Guam Extension Service, and the Guam Environmental Protection Agency.
5. Lay the groundwork for the Division's Aquatic and Hunter Education Programs.

Report prepared by: Lillian L. Mariano

**GUAM WILDLIFE INVESTIGATIONS**  
**PROJECT FW-2R-26**  
**Federal Aid in Wildlife Restoration Act**





## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26  
**SUB-PROJECT NO.:** W-1  
**STUDY NO.:** 1  
**JOB NO.:** 1

**JOB TITLE:** Determination of Current Population Size and Distribution of Guam Deer.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

Participation in the recreational hunting program decreased 9% during FY '89 as fewer hunting licenses were sold, a total of 564 licenses sold during the fiscal year. Deer hunting remained a popular past time and an estimated 343 hunters spent 4,116 days hunting and harvested 45 deer. Hunters were slightly more successful at harvesting deer this year (13%) than last (10%), however, the average effort required to harvest a deer still remains very high (91 days/deer). A special either-sex hunt was held at Pati Point on Andersen Air Force Base (AAFB) during the months of January and February. One-hundred-seventy-five tags were issued and 250 hunter-days were spent hunting deer in these special hunts. Fifty-three deer were harvested, of which 27 were bucks and 26 does. The gun special hunts provided the best opportunity to harvest a deer requiring just 4.0 days effort per deer harvested. The military bases on the northern end of the island were reported as the preferred areas to hunt deer. AAFB and NAVCAMS accounted for 49% and 24%, respectively, of the reported hunting effort. Bolanos and Cotal (Tarzan Falls) Territorial Conservation Reserves and private property received 8%, 11%, and 9%, respectively, of the reported effort. Population trend data obtained with spotlight counts indicated no significant change ( $P=0.35$ ) in deer numbers at AAFB but a significant increase ( $P=0.006$ ) in deer numbers at Naval Magazine. A fatal hunting accident between two Volunteer Base Game Wardens occurred on AAFB during the special hunt that resulted in the cessation of the base hunting program for the remainder of the fiscal year.

### **BACKGROUND**

The Guam deer has been under investigation by the Division of Aquatic & Wildlife Resources since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures. The regular deer season is October 1 through December 31 with a bag limit of one antlered deer (buck only) per season per license holder exclusive of any special hunt harvest. The Director of Agriculture can authorize a special either-sex hunt to thin a particular herd in situations where the population poses a threat to life and property and to prevent damage to other natural resources from over grazing.

## OBJECTIVES

To determine the current size and distribution of the deer population of Guam and to monitor population trends.

## PROCEDURES

1. Continue spotlight counts on AAFB at 21 counts per year, 4 per month in May - July and one per month in other months.
  - a. Record number, age, sex and group composition.
  - b. Statistically analyze count data and compare with past data to discern population trends.
2. Continue monthly spotlight counts on Naval Magazine with periodic spotlight counts in other areas.
3. Collect hunting statistics via a hunter questionnaire. Analyze hunting statistics for changes in hunter kill, effort, and hunting location.
4. Collect biological data from carcasses killed during regular season and special hunts or from incidental sources such as road kills or confiscated animals.

## RESULTS

### Deer Hunting Statistics

License sales declined 9% during FY '89 with 564 sold during the year. All license holders were mailed a harvest questionnaire and responses were obtained from 136 persons (24%). Outdated or incomplete mailing addresses were a problem and 6% of the mailed questionnaires were returned as undeliverable. Of the 136 persons responding to the questionnaire, 87% indicated they had hunted at some time during the October 1 - September 31 license year. Based on that percentage, an estimated 490 persons legally hunted game during the past year.

Seventy percent of those that reported hunting during FY '89 hunted during the regular deer season (Table 1). This represented no change from the participation reported the previous year. Hunter success, however, increased slightly to 13% from the 10% reported in FY '88. Of the 11 deer that were reported as harvested in the questionnaire, six came from Northwest Field, 2 from AAFB, and three from private property. Nine of these deer were taken by shotgun and two were taken with a bow. Deer hunters spent an average of 12 days pursuing deer.

Estimates of total hunter participation, effort, and harvest were derived from the questionnaires. Based on these data, an estimated 343 hunters spent 4,116 days hunting and harvested 45 deer, a 3% decrease in participation, 22% increase in harvest, and no change in effort over FY '88 levels. Deer hunters expended an average of 91 hunter-days of effort per deer harvested, a decrease from the 111.6 days/deer expended in FY '88.

The military bases on the northern end of the island remained the preferred areas to hunt deer. Andersen Air Force Base and NAVCAMS accounted for 49% and 24%, respectively, of the reported hunting effort of 974 hunter-days. Bolanos and Cotal (Tarzan

Falls) Territorial Conservation Reserves received 8% and 11%, respectively, of the reported effort and private property received 9% of the reported effort.

The shotgun remained the most heavily used weapon for deer hunting being used for 64% of the reported hunting effort. The handgun was next in popularity and was used during 21% of the hunting effort. Bows and rifles were less popular and were used for 9% and 6%, respectively, of the hunting effort.

A record of hunting activity and harvest is kept at NAVCAMS and AAFB during the regular season and special hunts (Table 2). According to logs, 539 hunter days (862 hunter-sorties) were expended on NAVCAMS and resulted in the harvest of 3 deer. The 3-deer harvest this year is half that of last year. No data are available on hunting effort for FY '88 (DAWR 1988) with which to make comparisons of effort expended this year.

The record of hunting activity and harvest appeared to be incomplete for Northwest Field and bow areas at the Conventional Weapons Storage Area (CWA) and on the main base. Only a few days of hunting are reported for Northwest Field during the month of October which usually has heavy participation. It appears that data sheets are missing for this month. Data provided indicated only 4 deer were harvested during the regular season at Northwest Field (Table 2), a drastic reduction from the 26 taken there the previous year. Hunting effort at 481 hunter-sorties and 344 days was also way down this year from the 1,077 hunter-sorties and 687 days spent hunting there the previous year. As was the case last year, bow areas received little hunting pressure and did not account for any harvest. No data were available for bow areas on the main base.

Special either-sex hunts were held at Pati Point during the months of January and February, 1989. One-hundred-seventy-five tags were issued and 250 hunter-days were spent hunting deer in these special hunts. Fifty-three deer were harvested of which 27 were bucks and 26 were does. The gun special hunts provided the best opportunity to harvest a deer requiring just 4.0 days effort per deer harvested.

Because of military exercises, the special hunts were cancelled on January 21-22, 1989. Sixteen gun and 1 bow hunter holding tags for these dates may not have had an opportunity to hunt. On February 20, 1989 the Base Commander closed all hunting on the base because of a fatal hunting accident. As a result of this action, 16 gun hunters selected for February 25 and 26 hunt did not have an opportunity to use their tag. As of the end of the fiscal year, hunting had not resumed on the base pending the establishment of an improved hunter safety program.

The hunting accident that occurred on the base involved two AAFB Volunteer Game Wardens when hunting in the same unit and one mistook the other for a deer. An inquiry into the accident by the Government of Guam found that there was negligence on the part of the shooter and resulted in a successful prosecution for manslaughter.

### **Spotlight Count Trends**

Deer numbers remained high on AAFB during FY '89 (Table 3). Numbers observed during the best 3 months of the year for sighting deer, May-July, were not significantly different from those observed during FY '88 (Mann-Whitney U-Test,  $U = 80.5$ ,  $n_1=12$ ,  $n_2=12$ ,  $P=0.62$ , Sokal and Rohlf 1981). The average number of deer seen per count decreased slightly (2%) from 131.4 during May-July, 1988 to 128.3 during May-July, 1989. Likewise, numbers observed throughout the entire year did not vary statistically from those recorded the previous year (Mann-Whitney U-Test,  $U = 218$ ,  $n_1=21$ ,  $n_2=20$ ,

P=0.35). The average number of deer seen per count (October-September) increased slightly (1%) from 115.2 in FY '88 to 116.8 in FY '89. The largest single nightly count increased from 166 (231 deer per 10 km) in FY '88 to 175 (249 deer per 10 km) in FY '89.

Deer numbers observed on Naval Magazine continued to increase during FY '89. Numbers observed on deer counts were significantly greater (Mann Whitney U-Test,  $U=120$ ,  $n_1=12$ ,  $n_2=12$ ,  $P=0.006$ ) than those observed the previous year. The average number of deer seen per count increased 81% from 18.3 deer in FY '88 to 33.1 deer in FY '89 (Table 4). The largest single nightly count increased from 32 deer (15.4 deer per 10 km) in FY '88 to 54 deer (24.5 deer per 10 km) in FY '89.

## RECOMMENDATION

Continue spotlight counts at present intensity at NAVMAG and AAFB. Collect biological data from carcasses as available.

## LITERATURE CITED

- Division of Aquatic and Wildlife Resources Division. 1988. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.
- Sokal, R. R. and F. J. Rohlf. 1981. Biometry. W. H. Freeman and Co. 859 pp.
- Wheeler, M.E. 1979. The biology of the Guam deer. Tech. Rept. No. 3. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao. 53 pp.

Report prepared by: Paul J. Conry



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Table 1. Island-wide deer hunting statistics for FY '89 based on hunter responses to a harvest questionnaire.

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|                                                                                   |      |
|-----------------------------------------------------------------------------------|------|
| a. Total license sales for all game species .....                                 | 564  |
| b. Number of questionnaires sent out.....                                         | 564  |
| c. Number of hunter questionnaires returned .....                                 | 136  |
| d. Percent of queried license buyers that responded.....                          | 24%  |
| e. Number of reporting license buyers (136) that hunted any species .....         | 118  |
| f. Percent of license buyers that hunted .....                                    | 87%  |
| g. Estimated total number of legal hunters.....                                   | 490  |
| h. Number of reporting hunters (118) that hunted deer during the regular season . | 83   |
| i. Percent of reporting hunters that hunted deer during the regular season.....   | 70%  |
| j. Number of deer taken by 83 deer hunters .....                                  | 11   |
| k. Hunter success.....                                                            | 13%  |
| l. Hunter-days expended by 81 reporting deer hunters.....                         | 974  |
| m. Average number of days spent per reporting deer hunter.....                    | 12   |
| n. Estimated total number of legal deer hunters .....                             | 343  |
| o. Estimated total legal deer take.....                                           | 45   |
| p. Estimated total number of days spent hunting deer.....                         | 4116 |
| q. Number of days spent hunting per deer taken .....                              | 91   |

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Table 2. Hunter effort and deer take based on official hunter logs from Naval Communication Area Master Station (NAVCAMS), Northwest Field, and bow areas and special hunts on Andersen Air Force Base during FY '89.

|                                          | Oct   | Nov | Dec     | Jan | Feb | Total |
|------------------------------------------|-------|-----|---------|-----|-----|-------|
| NAVCAMS                                  |       |     |         |     |     |       |
| No. hunter-sorties                       | 384   | 245 | 233     |     |     | 862   |
| No. hunter-days (8-hr)                   | 243   | 148 | 148     |     |     | 539   |
| Deer taken                               | 2     | 0   | 1       |     |     | 3     |
| Days effort/take                         | 121.5 | --  | 148     |     |     | 179.7 |
| Anderson Air Force Base                  |       |     |         |     |     |       |
| Northwest Field                          |       |     |         |     |     |       |
| No. hunter-sorties                       | 18    | 207 | 256     |     |     | 481   |
| No. hunter-days (8-hr)                   | 9     | 140 | 195     |     |     | 344   |
| Deer taken                               | 1     | 1   | 2       |     |     | 4     |
| Days effort/take                         | 9.0   | 140 | 97.5    |     |     | 86    |
| Bow Area at Conventional Weapons Storage |       |     |         |     |     |       |
| No. hunter-sorties                       | 12    | 9   |         |     |     | 21    |
| No. hunter-days (8-hr)                   | 10    | 7   |         |     |     | 17    |
| Deer taken                               | 0     | 0   |         |     |     | 0     |
| Days effort/take                         | --    | --  |         |     |     | --    |
| Bow Areas on Main Base                   |       |     | NO DATA |     |     |       |
| Special Hunt -Gun                        |       |     |         |     |     |       |
| No. hunter-sorties*                      |       |     |         | 145 | 69  | 214   |
| No. hunter-days (8-hr)                   |       |     |         | 134 | 65  | 199   |
| Deer taken                               |       |     |         | 32  | 18  | 50    |
| Days effort/take                         |       |     |         | 4.2 | 3.6 | 4.0   |
| Special Hunt -Bow                        |       |     |         |     |     |       |
| No. hunter-sorties*                      |       |     |         | 64  | 14  | 78    |
| No. hunter-days (8-hr)                   |       |     |         | 42  | 9   | 51    |
| Deer taken                               |       |     |         | 3   | 0   | 3     |
| Days effort/take                         |       |     |         | 14  | --  | 17    |
| Totals Andersen Air Force Base           |       |     |         |     |     |       |
| No. hunter-sorties                       | 30    | 216 | 256     | 209 | 83  | 794   |
| No. hunter-days (8-hr)                   | 19    | 147 | 195     | 176 | 74  | 611   |
| Deer taken                               | 1     | 1   | 2       | 35  | 18  | 57    |
| Days effort/take                         | 19    | 147 | 97.5    | 5.0 | 4.1 | 10.7  |

\*In the case of the special hunts, a hunter-sortie is equivalent to a hunter-day.

Table 3. Composition of deer herd seen during spotlight counts at Andersen Air Force Base, during FY '89.

|                   |   | 1988  |       |       |       | 1989 |     |       |       |       |       |       |       | Summary Statistics |       |       |      |      |
|-------------------|---|-------|-------|-------|-------|------|-----|-------|-------|-------|-------|-------|-------|--------------------|-------|-------|------|------|
|                   |   | COUNT | OCT   | NOV   | DEC   | JAN  | FEB | MAR   | APR   | MAY   | JUN   | JUL   | AUG   | SEP                | TOTAL | AVE.  | SD   | CV-% |
| Unclassed buck    | 1 | 2     | 4     | 1     | 0     |      |     | 2     | 4     | 2     | 1     | 6     | 7     | 0                  | 61    | 3.1   | 2.2  | 71   |
|                   | 2 |       |       |       |       |      |     |       |       | 5     | 3     | 3     |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 2     | 6     | 6     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 4     |       | 0     |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 3     |       |       |       |                    |       |       |      |      |
| Ave.              |   | 2.0   | 4.0   | 1.0   | 0.0   |      |     | 2.0   | 4.0   | 3.2   | 3.3   | 3.8   | 7.0   | 0.0                |       |       |      |      |
| Spike             | 1 | 4     | 6     | 4     | 1     |      |     | 1     | 1     | 1     | 2     | 3     | 3     | 1                  | 54    | 2.7   | 2.8  | 103  |
|                   | 2 |       |       |       |       |      |     |       |       | 1     | 1     | 9     |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 1     | 2     | 3     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 0     |       | 10    |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 0     |       |       |       |                    |       |       |      |      |
| Ave.              |   | 4.0   | 6.0   | 4.0   | 1.0   |      |     | 1.0   | 1.0   | 0.6   | 1.7   | 6.3   | 3.0   | 1.0                |       |       |      |      |
| 2pt               | 1 | 1     | 0     | 0     | 3     |      |     | 2     | 3     | 1     | 2     | 0     | 2     | 1                  | 33    | 1.7   | 1.5  | 91   |
|                   | 2 |       |       |       |       |      |     |       |       | 2     | 5     | 0     |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 0     | 1     | 2     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 1     |       | 5     |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 2     |       |       |       |                    |       |       |      |      |
| Ave.              |   | 1.0   | 0.0   | 0.0   | 3.0   |      |     | 2.0   | 3.0   | 1.2   | 2.7   | 1.8   | 2.0   | 1.0                |       |       |      |      |
| 3pt               | 1 | 5     | 7     | 0     | 2     |      |     | 2     | 2     | 3     | 5     | 6     | 6     | 1                  | 75    | 3.8   | 1.9  | 52   |
|                   | 2 |       |       |       |       |      |     |       |       | 6     | 2     | 4     |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 3     | 4     | 6     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 3     |       | 3     |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 5     |       |       |       |                    |       |       |      |      |
| Ave.              |   | 5.0   | 7.0   | 0.0   | 2.0   |      |     | 2.0   | 2.0   | 4.0   | 3.7   | 4.8   | 6.0   | 1.0                |       |       |      |      |
| 4pt               | 1 | 2     | 0     | 0     | 0     |      |     | 0     | 0     | 1     | 0     | 0     | 3     | 2                  | 13    | 0.7   | 1.0  | 160  |
|                   | 2 |       |       |       |       |      |     |       |       | 0     | 0     | 0     |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 0     | 0     | 1     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 3     |       | 0     |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 1     |       |       |       |                    |       |       |      |      |
| Ave.              |   | 2.0   | 0.0   | 0.0   | 0.0   |      |     | 0.0   | 0.0   | 1.0   | 0.0   | 0.3   | 3.0   | 2.0                |       |       |      |      |
| Doe               | 1 | 41    | 33    | 40    | 33    |      |     | 31    | 48    | 48    | 60    | 71    | 76    | 58                 | 1018  | 50.9  | 13.0 | 26   |
|                   | 2 |       |       |       |       |      |     |       |       | 51    | 57    | 57    |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 39    | 65    | 64    |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 43    |       | 60    |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 43    |       |       |       |                    |       |       |      |      |
| Ave.              |   | 41.0  | 33.0  | 40.0  | 33.0  |      |     | 31.0  | 48.0  | 44.8  | 60.7  | 63.0  | 76.0  | 58.0               |       |       |      |      |
| Yearling          | 1 | 9     | 13    | 1     | 2     |      |     | 12    | 3     | 7     | 10    | 4     | 13    | 6                  | 170   | 8.5   | 4.5  | 53   |
|                   | 2 |       |       |       |       |      |     |       |       | 6     | 7     | 6     |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 6     | 18    | 9     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 12    |       | 14    |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 12    |       |       |       |                    |       |       |      |      |
| Ave.              |   | 9.0   | 13.0  | 1.0   | 2.0   |      |     | 12.0  | 3.0   | 8.6   | 11.7  | 8.3   | 13.0  | 6.0                |       |       |      |      |
| Fawn              | 1 | 5     | 7     | 7     | 4     |      |     | 9     | 3     | 1     | 13    | 8     | 12    | 6                  | 138   | 6.9   | 3.2  | 47   |
|                   | 2 |       |       |       |       |      |     |       |       | 5     | 8     | 12    |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 6     | 9     | 9     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 3     |       | 7     |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 4     |       |       |       |                    |       |       |      |      |
| Ave.              |   | 5.0   | 7.0   | 7.0   | 4.0   |      |     | 9.0   | 3.0   | 3.8   | 10.0  | 9.0   | 12.0  | 6.0                |       |       |      |      |
| Unclassed-deer    | 1 | 20    | 25    | 25    | 25    |      |     | 39    | 24    | 53    | 44    | 49    | 53    | 29                 | 774   | 38.7  | 11.3 | 29   |
|                   | 2 |       |       |       |       |      |     |       |       | 50    | 51    | 32    |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 42    | 37    | 31    |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 49    |       | 48    |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 48    |       |       |       |                    |       |       |      |      |
| Ave.              |   | 20.0  | 25.0  | 25.0  | 25.0  |      |     | 39.0  | 24.0  | 48.4  | 44.0  | 40.0  | 53.0  | 29.0               |       |       |      |      |
| Total             | 1 | 89    | 95    | 78    | 70    |      |     | 98    | 88    | 117   | 137   | 147   | 175   | 104                | 2336  | 116.8 | 26.6 | 23   |
|                   | 2 |       |       |       |       |      |     |       |       | 126   | 134   | 123   |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 99    | 142   | 131   |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 118   |       | 147   |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 118   |       |       |       |                    |       |       |      |      |
| Ave.              |   | 89.0  | 95.0  | 78.0  | 70.0  |      |     | 98.0  | 88.0  | 115.6 | 137.7 | 137.0 | 175.0 | 104.0              |       |       |      |      |
| Miles (Ave.)      |   | 4.2   | 4.1   | 4.1   | 4.2   |      |     | 4.7   | 4.6   | 4.5   | 4.1   | 4.2   | 4.4   | 4.1                | 253.7 | 251.9 | 72.4 | 29   |
| Km (Ave.)         |   | 6.7   | 6.6   | 6.6   | 6.7   |      |     | 7.5   | 7.4   | 7.2   | 6.6   | 6.7   | 7.0   | 6.6                |       |       |      |      |
| Deer/10 mi (Ave.) |   |       | 211.9 | 231.7 | 190.2 |      |     | 166.7 | 208.5 | 191.3 | 256.9 | 335.8 | 326.2 | 397.7              |       |       |      |      |
| Deer/10 km (Ave.) |   |       | 132.4 | 144.8 | 118.9 |      |     | 104.2 | 130.3 | 119.6 | 160.6 | 209.9 | 203.9 | 248.6              |       |       |      |      |
| Bucks-in-velvet   | 1 | 1     | 4     | 2     | 0     |      |     | 0     | 1     | 2     | 0     | 7     | 5     | 0                  | 54    | 2.7   | 2.4  | 88   |
|                   | 2 |       |       |       |       |      |     |       |       | 4     | 2     | 6     |       |                    |       |       |      |      |
|                   | 3 |       |       |       |       |      |     |       |       | 0     | 4     | 6     |       |                    |       |       |      |      |
|                   | 4 |       |       |       |       |      |     |       |       | 2     |       | 6     |       |                    |       |       |      |      |
|                   | 5 |       |       |       |       |      |     |       |       | 2     |       |       |       |                    |       |       |      |      |
| Ave.              |   | 1.0   | 4.0   | 2.0   | 0.0   |      |     | 0.0   | 1.0   | 2.0   | 2.0   | 6.3   | 5.0   | 0.0                |       |       |      |      |

Table 4. Composition of deer herd seen during spotlight counts at Naval Magazine, Guam during FY '89.

|                | 1988 |      |      | 1989 |      |      | Summary Statistics |      |      |      |      |      |       |      |       |      |
|----------------|------|------|------|------|------|------|--------------------|------|------|------|------|------|-------|------|-------|------|
|                | OCT  | NOV  | DEC  | JAN  | FEB  | MAR  | APR                | MAY  | JUN  | JUL  | AUG  | SEP  | TOTAL | AVE. | SD    | CV-% |
| Unclassed buck | 0    | 1    | 0    | 0    | 3    | 2    | 1                  | 1    | 2    | 3    | 1    | 2    | 16    | 1.3  | 1.07  | 80   |
| Spike          | 1    | 1    | 3    | 2    | 4    | 1    | 0                  | 0    | 2    | 0    | 0    | 1    | 15    | 1.3  | 1.29  | 103  |
| 2pt            | 0    | 2    | 1    | 4    | 0    | 0    | 0                  | 1    | 1    | 0    | 0    | 0    | 9     | 0.8  | 1.22  | 162  |
| 3pt            | 0    | 0    | 1    | 1    | 1    | 2    | 0                  | 4    | 0    | 3    | 1    | 1    | 14    | 1.2  | 1.27  | 109  |
| 4pt            | 0    | 0    | 0    | 0    | 1    | 0    | 0                  | 0    | 0    | 0    | 0    | 1    | 2     |      |       |      |
| Doe            | 8    | 9    | 15   | 18   | 24   | 8    | 8                  | 20   | 12   | 18   | 7    | 11   | 158   | 13.2 | 5.69  | 43   |
| Yearling       | 1    | 1    | 1    | 5    | 1    | 0    | 1                  | 2    | 0    | 1    | 3    | 2    | 18    | 1.5  | 1.38  | 92   |
| Fawn           | 1    | 2    | 2    | 4    | 4    | 2    | 4                  | 5    | 2    | 1    | 2    | 5    | 34    | 2.8  | 1.47  | 52   |
| Unclassed deer | 3    | 4    | 2    | 10   | 16   | 11   | 9                  | 13   | 6    | 26   | 22   | 9    | 131   | 10.9 | 7.40  | 68   |
| Total          | 14   | 20   | 25   | 44   | 54   | 26   | 23                 | 46   | 25   | 52   | 36   | 32   | 397   | 33.1 | 13.17 | 40   |
| Miles traveled | 13.6 | 14.6 | 14.4 | 13.1 | 13.7 | 13.2 | 14.9               | 14.8 | 14.8 | 13.2 | 13.2 | 13.3 | 166.8 | 13.9 |       |      |
| Km traveled    | 21.9 | 23.5 | 23.2 | 21.1 | 22.0 | 21.2 | 24.0               | 23.8 | 23.8 | 21.2 | 21.2 | 21.4 | 268.4 | 22.4 |       |      |
| Deer/10 mi     | 10.3 | 13.7 | 17.4 | 33.6 | 39.4 | 19.7 | 15.4               | 31.1 | 16.9 | 39.4 | 27.3 | 24.1 | 288.2 | 24.0 | 10.04 | 42   |
| Deer/10 km     | 6.4  | 8.5  | 10.8 | 20.9 | 24.5 | 12.2 | 9.6                | 19.3 | 10.5 | 24.5 | 16.9 | 15.0 | 179.1 | 14.9 | 6.24  | 42   |
| Water Buffalo  | 46   | 25   | 59   | 72   | 77   | 33   | 57                 | 85   | 43   | 47   | 47   | 85   | 676.0 | 56.3 | 19.79 | 35   |
| Buffalo/10 mi  | 33.8 | 17.1 | 41.0 | 55.0 | 56.2 | 25.0 | 38.3               | 57.4 | 29.1 | 35.6 | 35.6 | 63.9 | 487.9 | 40.7 | 14.48 | 36   |
| Buffalo/10 km  | 21.0 | 10.6 | 25.5 | 34.2 | 34.9 | 15.5 | 23.8               | 35.7 | 18.1 | 22.1 | 22.1 | 39.7 | 303.2 | 25.3 | 9.00  | 36   |



**FINAL REPORT  
RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** W-1

**STUDY NO.:** 2

**JOB NO.:** 1

**JOB TITLE:** Preparation of a Status Report on Wild Pigs.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

**OBJECTIVES**

To prepare a status report on wild pigs to be used in planning future work.

**RESULTS**

This project was completed during Segment 26 and published in June 1989 as the Division of Aquatic and Wildlife Resources Technical Report No. 7, Ecology of the Wild (Feral) Pig (*Sus Scrofa*) on Guam. This report is now available for distribution and can be obtain upon request by writing to the Division Chief, Division of Aquatic & Wildlife Resources, Department of Agriculture, P.O. Box 2950, Agana, Guam 96910.

Report prepared by: Paul J. Conry

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-26

SUB-PROJECT NO.: W-1

STUDY NO.: 2

JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam.

PERIOD COVERED: October 1, 1988 to September 30, 1989

### SUMMARY

The levels of interest in hunting and the harvest of pigs declined during FY '89 from levels reported during the previous year. An estimated 387 pig hunters spent 6,850 hunter-days and harvested an estimated 1,586 pigs, a decrease of 5% in hunter participation, 30% in hunter effort, and 20% in harvest from FY '88 levels. Hunter success also declined from 75% in FY '88 to 60% this year but the average take per successful hunter increased slightly from 6.4 to 6.8 pigs this past year. It required slightly less effort to harvest a pig this year than last, 4.32 days/pig in FY '89 versus 4.91 days/pig in FY '88. Naval Communications Area Master Station (NAVCAMS), private property, and Northwest Field were identified as the more important pig hunting areas on Guam accounting for 40%, 28%, and 22% of the effort expended during the year. Anao, Bolanos, and Cotal (Tarzan Falls Territorial Conservation Reserves) were also reported as hunted. A fatal hunting accident occurred on Andersen Air Force Base (AAFB) during February 1989 and resulted in the cessation of the hunting program for all areas of the base during the remainder of the fiscal year. This closure dramatically reduced the amount of pig hunting that occurred on AAFB. The official logs recording hunting statistics for AAFB documented hunting effort of 507 hunter-sorties comprising 358 hunter-days with a harvest of 50 pigs, and effort/harvest of 7.2 days per pig at Northwest Field. Hunter logs from NAVCAMS documented hunting statistics of 1,632 hunter-sorties, 1003 hunter-days, a harvest of 119 pigs, and effort/harvest of 8.4 hunter-days per pig for the year.

### BACKGROUND

The wild pig (*Sus scrofa*) has long been an important natural resource on Guam and accounts for the greatest annual hunter recreation and harvest of all game animals. This species has been under investigation by the Division of Aquatic and Wildlife Resources since 1967 and the results of those and more recent studies have been summarized in a Division Technical Report (Conry 1988). The wild pig on Guam is a descendant of domestic *Sus scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found island-wide but appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam. Pigs occur at high enough densities in many areas that rooting and wallowing damage are common in most forested areas and can be quite severe locally. Depredation on agricultural crops is also a problem, particularly so for farmers in southern Guam during the dry season. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers

and current hunting regulations provide for a year-round season with bags limits of 2 pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations island-wide and in localized areas.

## OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

## PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.
2. Monitor hunter participation and harvest during the legal hunting season.

## RESULTS

License sales declined 9% during FY '89 with 564 sold during the year. All license holders were mailed a hunter questionnaire and responses were obtained from 136 persons (24%). Outdated or incomplete mailing addresses were a problem and 6% of the mailed questionnaires were returned as undeliverable. Of the 136 persons responding to the questionnaire, 87% indicated they had hunted at some time during the October 1 - September 31 license year. Based on that percentage, an estimated 490 persons legally hunted game during the past year.

Hunter participation in pig hunting remained high during FY '89, with 79% of the responding hunters indicating they had hunted pigs during the FY '89 season (Table 1). The percentage of hunters succeeding in harvesting at least one pig during the year-long season dropped from the 75% reported the previous year to 60% this year. However, the average take per successful hunter increased slightly from 6.4 pigs in FY '88 to 6.8 this year. Pig hunters spent less time in the field this year than last, an average of 18 days per hunter and a considerable decline from the 24-day average in FY '88. It required slightly less effort to harvest a pig this year, 4.32 days/pig in FY '89 versus 4.91 days/pig in FY '88.

Estimates of hunter participation, effort, and harvest derived from hunter questionnaires revealed a decrease in participation, effort and harvest from the previous year. An estimated 387 hunters spent 6,850 days and harvested 1,586 pigs in FY '89. In FY '88, 409 pig hunters spent 9,775 days hunting pigs and harvested 1,992 pigs yielding a decreased in hunter participation of 5%, hunter effort of 30%, and harvest of 20%. Although participation, effort and harvest declined, it required slightly less effort to harvest a pig this year than last.

The estimated total hunter participation, effort, and harvest seem far higher than actual activity and are likely over-estimates of effort and take. These results reflect the bias typical of hunter questionnaires where successful hunters are far more likely to report their activities than unsuccessful ones. Consequently, information derived from this questionnaire is more useful as an index of hunter activity than as an absolute estimate of it.

The shotgun remained the most heavily used weapon for pig hunting and was used during 63% of the reported effort and accounted for 68% of the harvest. Hand gun hunting was next in popularity being used in 27% of the effort and accounting for

21% of the harvest. Archery hunting and rifle hunting accounted for 7% and 3% of the effort and accounted for 6% and 5%, respectively, of the harvest.

The military bases on the northern end of the island received the greatest amount of hunting effort. Northwest Field and NAVCAMS received 22% and 40%, of the reported hunting effort and accounted for 18% and 30%, respectively, of the harvest. Private property received 28% of the effort and accounted for 41% of the harvest. Anao, Bolanos, and Cotal (Tarzan Falls) Territorial Conservation Reserves received 4%, 2%, and 5% of the hunting effort and accounted for 5%, 1%, and 6%, respectively, of the harvest.

A hunting log was kept at NAVCAMS and Andersen Air Force Base to monitor hunting activity and harvest (Table 2). A fatal hunting accident between two Volunteer Base Game Wardens occurred on AAFB during the February special hunt and resulted in the cessation of the hunting program for all areas of the base during the remainder of the fiscal year. This closure dramatically reduced the amount of pig hunting that occurred on AAFB during the year.

In addition to the complete lack of hunting during March through September, the record of hunting activity and harvest appeared to be incomplete for Northwest Field and bow areas for other months. Only a few days of hunting are reported for Northwest Field during the month of October, which usually has heavy participation, and it appears that data sheets are missing for this month. Data provided for the months of October through February indicated a harvest of 50 pigs during this portion of the regular season at Northwest Field (Table 2), a drastic reduction from the 103 taken during this period the previous year and the 151 taken over the entire FY '88 season. Hunting effort at 507 hunter-sorties and 358 days was also way down from the 1,502 hunter-sorties and 957 hunter-days spent hunting there the previous year. Effort per take at 7.2 days/pig was slightly higher than the 6.3 days/pig recorded during FY '88. As was the case with NWF, there appeared to be missing data on hunting effort and harvest from bow areas on the main base and CWA. Only 2 pigs were reported harvested by bow during the entire season.

The record of hunting activity appeared to be complete from NAVCAMS. According to hunter logs, 1,003 hunter days (1,632 hunter-sorties) were expended on NAVCAMS and resulted in the harvest of 119 pigs at an average effort of 8.4 days per pig taken. An incomplete data set is available on hunting effort and harvest for FY '88 but data available indicated a slight increase in harvest and a reduction in the amount of effort required per pig taken during this year (DAWR 1988).

## RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases.



## LITERATURE CITED

Conry, P. J. 1988. Ecology of the wild (feral) pig (*Sus scrofa*) on Guam. Tech. Rept. No. 7. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao. 60 pp.

Division of Aquatic and Wildlife Resources. 1988. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.

Report prepared by: Paul J. Conry

**Table 1.** Pig hunting statistics for FY '89 compiled from a harvest questionnaire.

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|    |                                                                        |      |
|----|------------------------------------------------------------------------|------|
| a. | Total license sales for all game species .....                         | 564  |
| b. | Number of questionnaires sent out.....                                 | 564  |
| c. | Number of questionnaires returned .....                                | 136  |
| d. | Percent of queried license buyers that responded .....                 | 24%  |
| e. | Number of reporting license buyers (136) that hunted any species ..... | 118  |
| f. | Percent of license buyers that hunted .....                            | 87%  |
| g. | Estimated total number of legal hunters .....                          | 490  |
| h. | Number of reporting hunters (118) that hunted pigs.....                | 93   |
| i. | Percent of reporting hunters that hunted pigs.....                     | 79%  |
| j. | Number of successful pig hunters .....                                 | 56   |
| k. | Hunter success .....                                                   | 60%  |
| l. | Number of pigs taken by the 56 successful pig hunters.....             | 379  |
| m. | Average number of pigs taken per pig hunter.....                       | 4.1  |
| n. | Average number of pigs taken per successful hunter .....               | 6.8  |
| o. | Number of hunter days expended by 89 reporting pig hunters.....        | 1577 |
| p. | Average number of days spent per reporting pig hunter.....             | 17.7 |
| q. | Estimated total number of legal pig hunters.....                       | 387  |
| r. | Estimated total legal pig take.....                                    | 1586 |
| s. | Estimated total number of days spent hunting pigs .....                | 6850 |
| t. | Days of hunting effort per pig taken .....                             | 4.32 |

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**Table 2.** Hunter effort and pig take based on official hunter logs from Naval Communications Area Master Station (NAVCAMS) and Andersen Air Force Base (AAFB) during FY '89. Note there was no hunting on AAFB from March - September.

|                                                  | Oct  | Nov  | Dec  | Jan | Feb | Mar | April | May | June | July | Aug  | Sept | Total |
|--------------------------------------------------|------|------|------|-----|-----|-----|-------|-----|------|------|------|------|-------|
| <b>NAVCAMS</b>                                   |      |      |      |     |     |     |       |     |      |      |      |      |       |
| No. hunter sorties                               | 384  | 245  | 233  | 121 | 24  | 138 | 78    | 56  | 94   | 86   | 79   | 94   | 1632  |
| No. hunter days (8-hr)                           | 243  | 148  | 148  | 66  | 14  | 85  | 47    | 33  | 54   | 63   | 48   | 54   | 1003  |
| Pigs taken                                       | 14   | 14   | 19   | 10  | 0   | 11  | 8     | 7   | 11   | 15   | 4    | 6    | 119   |
| Days effort/take                                 | 17.4 | 10.6 | 7.8  | 6.6 | --  | 7.7 | 5.9   | 4.7 | 4.9  | 4.2  | 12.0 | 9.0  | 8.4   |
| <b>Andersen Air Force Base</b>                   |      |      |      |     |     |     |       |     |      |      |      |      |       |
| <b>Northwest Field</b>                           |      |      |      |     |     |     |       |     |      |      |      |      |       |
| No. hunter sorties                               | 18   | 207  | 256  | 10  | 16  |     |       |     |      |      |      |      | 507   |
| No. hunter days (8-hr)                           | 9    | 140  | 195  | 6   | 8   |     |       |     |      |      |      |      | 358   |
| Pigs taken                                       | 2    | 20   | 18   | 4   | 6   |     |       |     |      |      |      |      | 50    |
| Days effort/take                                 | 4.5  | 7.0  | 10.8 | 1.5 | 1.3 |     |       |     |      |      |      |      | 7.2   |
| <b>Bow Areas at Conventional Weapons Storage</b> |      |      |      |     |     |     |       |     |      |      |      |      |       |
| No. hunter sorties                               | 12   | 9    |      |     |     |     |       |     |      |      |      |      | 21    |
| No. hunter days (8-hr)                           | 10   | 7    |      |     |     |     |       |     |      |      |      |      | 17    |
| Pigs taken                                       | 2    | 0    |      |     |     |     |       |     |      |      |      |      | 2     |
| Days effort/take                                 | 5.0  | --   |      |     |     |     |       |     |      |      |      |      | 8.5   |
| <b>Bow Areas on Main Base</b>                    |      |      |      |     |     |     |       |     |      |      |      |      |       |
| <b>NO DATA</b>                                   |      |      |      |     |     |     |       |     |      |      |      |      |       |
| <b>Totals Andersen Air Force Base</b>            |      |      |      |     |     |     |       |     |      |      |      |      |       |
| No. hunter sorties                               | 30   | 216  | 256  | 10  | 16  |     |       |     |      |      |      |      | 528   |
| No. hunter days (8-hr)                           | 19   | 147  | 195  | 6   | 8   |     |       |     |      |      |      |      | 375   |
| Pigs taken                                       | 4    | 20   | 18   | 4   | 6   |     |       |     |      |      |      |      | 52    |
| Days effort/take                                 | 4.8  | 7.4  | 10.8 | 1.5 | 1.3 |     |       |     |      |      |      |      | 7.2   |

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-26  
SUB-PROJECT NO.: W-2  
STUDY NO.: 1  
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves.

PERIOD COVERED: October 1, 1988 to September 30, 1989

### SUMMARY

The decline in the island-wide population of Philippine Turtle-Doves (*Streptopelia bitorquata*) over the past five to ten years may have run its course as spring game bird surveys conducted last year showed a general increasing trend followed by stabilization this year. For the first time in four years, monthly stationary counts at Northwest Field (NWF) and roadside counts at the Conventional Weapons Area (CWA) on Andersen Air Force Base showed a significant increase in numbers from the previous year (NWF:  $P = 0.005$ , CWA  $P = 0.001$ ). An average of 34.3 doves were recorded per count at NWF, up 42% from FY '88 levels. Likewise, roadside counts in the CWA exhibited a similar trend with an average of 32.7 doves recorded per count, an increase of 42% from FY '88 levels. Turtle-doves remain distributed throughout the island and were observed on all 23 spring game bird surveys conducted during June. The number of doves observed per station increased on 11 routes, remained the same on 3 routes, and decreased on 9 routes. No statistically significant ( $P = 0.48$ ) pattern of change was evident in the data and the differences in survey results between last year and now can be attributed to random fluctuations in local populations. Doves were found in high numbers ( $\geq 1.0$  birds/station) on the Cocos Island, Navy Golf Course in Barrigada, CWA, NWF, Orote Point, Merizo, Tarague, Mt. Santa Rosa, and Andy South routes. The largest increase in numbers occurred on the Cocos Island, Navy Barrigada, and Orote Point survey routes where the average station count increase was  $\geq 1.0$  birds/station.

### BACKGROUND

The Philippine Turtle-Dove (*Streptopelia bitorquata*) was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951) and has been regulated as a game bird since as early as 1903 (Conry 1987). Up through the early 1960's, the turtle-dove was very common and found in large numbers in both northern and southern Guam. By the late 1960's, dove populations in southern and central Guam began to decline and have since stabilized at low levels. Populations in northern Guam declined in the late 1970's and early 1980's. Turtle-doves are now found in appreciable numbers in prime dove habitat on Northwest Field, Conventional Weapons Area and elsewhere on Andersen Air Force Base and at moderate numbers in selected areas of central and southern Guam. A large population still remains on snake-free Cocos Island. Predation by the brown tree snake (*Boiga irregularis*) is the major cause of nest loss (Conry 1988) and this introduced pest is thought to be responsible for the population decline. Because of the



decline in numbers and the extremely poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season as of March 28, 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

## OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.
2. To investigate nesting success and causes of nest failures.

## PROCEDURES

Call-count and roadside-count surveys were conducted at Northwest Field (NWF) and the Conventional Weapons Storage Area (CWA) on Andersen Air Force Base. Both surveys were conducted twice monthly in early morning. The call-count survey consisted of counting the number and species of doves seen or heard during a 5-minute period at 10 stations in NWF plus the number of doves seen enroute between stations. The roadside-count survey at CWA involved counting the number of Philippine Turtle-Doves seen while driving at 25 km per hour along an established 32 km route. The Philippine Turtle-Dove is also included in a twice monthly roadside-count of all birds conducted by DAWR Staff in 3 areas of northern Guam. The results of these surveys are reported in Job W-1-3.

Philippine Turtle-doves were additionally surveyed during spring game bird counts conducted on 23 routes throughout the island in June. These surveys consisted of 5-minute station counts at up to 10 stations per route with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds observed per station.

## RESULTS

### Population Surveys

Call count surveys and roadside counts were continued at NWF and the CWA on Andersen Air Force Base (Table 1). For the first time in four years, surveys on NWF showed a significant increase over the previous year (Mann Whitney U-Test,  $n_1 = 22$ ,  $n_2 = 21$ ,  $U = 347$ ,  $P = 0.005$ , Sokal and Rolf 1981). The average count increased dramatically (42%) from 24.2 birds/survey in FY '88 to 34.3 birds/survey in FY '89. This is the first significant increase in numbers that has occurred since these counts were started in 1983.

Roadside counts in the CWA exhibited a similar trend and showed a significant increase over previous years counts (Mann Whitney U-Test,  $n_1 = 23$ ,  $n_2 = 20$ ,  $U = 361.5$ ,  $P = 0.001$ ). As occurred in NWF, the average count per survey increased dramatically (42%) from 23.1 birds/count in FY '88 to 32.7 birds/count in FY '89. This is the first significant increase in numbers that has occurred since these counts were started in 1983.

Two observations of Mariana Fruit-Dove (*Ptilinopus roseicapilla*) were made in NWF during this fiscal year. One visual sighting was made on the September 11, 1989 NWF survey and a second observation was made incidental to other field work. This species

was last seen on one of the NWF or CWA surveys during FY '85. No White-throated Ground-Doves (*Gallicolumba xanthonura*) were recorded on either of the NWF or CWA surveys during FY '89 with the most recent previous record on these surveys occurring in FY '86. However, one ground-dove was heard calling in the CWA area of AAFB on September 6, 1989.

### Spring Game Bird Surveys

Turtle-doves were recorded on all 23 spring game bird surveys conducted during 1988 (Table 2). Snake free Cocos Island had the highest count on the island by far with an average of 8.0 birds observed per station. The antenna fields and golf course at Navy Barrigada had the next highest count with 2.3 birds/station recorded there. The CWA, NWF, Orote Point, Merizo, Tarague, Mt. Santa Rosa, and Andy South routes also had station counts  $\geq 1.0$  bird/station. The largest increases in numbers occurred on the Cocos Island, Navy Golf Course, and Orote Point surveys where the average station count increase was  $\geq 1.0$  birds/station. There appeared to be no consistent trend in population change over the entire island as the number of stations that showed an increase in numbers was only slightly larger than the number that showed a decrease. Numbers increased on 11 routes, remained the same on 3 routes, and decreased on 9 routes. This pattern of change was not statistically significantly different from random variation (Wilcoxon Signed-rank Test,  $Z = -0.71$ ,  $P = 0.48$ ) indicating there was no island-wide increase or decrease in population levels. This random pattern of change was consistent in both the northern and southern portions of the island. Survey numbers increased on 5, remained the same on 3, and decreased on 4 routes in northern Guam and increased on 6 and declined on 5 routes in southern Guam.

### RECOMMENDATIONS

1. Continue call count and roadside count surveys in northern Guam to monitor distribution, relative abundance and population trends of the Philippine Turtle-Dove.
2. Keep Philippine Turtle-Dove hunting season closed until nesting success improves and the population recovers.

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Report prepared by: Paul J. Conry

Table 1. Numbers of birds observed per count and monthly average in Philippine Turtle-Dove surveys at Northwest Field (NWF) and the Conventional Weapons Area (CWA) on Andersen Air Force Base, Guam during FY '89.

| Month          | NWF Surveys |    |    |         | CWA Surveys |    |    |         |
|----------------|-------------|----|----|---------|-------------|----|----|---------|
|                | 1           | 2  | 3  | Average | 1           | 2  | 3  | Average |
| 1988           |             |    |    |         |             |    |    |         |
| October        | 35          | 32 |    | 33.5    | 38          | 36 | 30 | 34.7    |
| November       | 38          |    |    | 38.0    | 28          |    |    | 28.0    |
| December       | 36          | 28 |    | 32.0    | 28          | 29 |    | 28.5    |
| 1989           |             |    |    |         |             |    |    |         |
| January        | 39          | 35 |    | 37.0    | 26          | 36 |    | 31.0    |
| February       | 22          | 33 |    | 27.5    | 36          | 42 |    | 39.0    |
| March          | 38          | 34 |    | 36.0    | 43          | 46 |    | 44.5    |
| April          | 42          | 34 |    | 38.0    | 38          | 23 |    | 30.5    |
| May            | 42          |    |    | 42.0    | 35          | 33 |    | 34.0    |
| June           | 25          |    |    | 25.0    | 29          |    |    | 29.0    |
| July           | 32          |    |    | 32.0    | 26          | 31 |    | 28.5    |
| August         | 39          | 37 |    | 38.0    | 28          | 29 |    | 28.5    |
| September      | 35          | 34 | 30 | 33.0    | 28          | 35 |    | 31.5    |
| Survey Average |             |    |    | 34.3    |             |    |    | 32.7    |

Table 2. Numbers of Philippine Turtle-Doves observed per count and average number of birds per station as detected in spring game bird surveys at various locations on Guam during June 1989. Values in the trend column are the difference between the average station count between years.

| Survey Location            | No.<br>Stations | No.<br>Doves<br>Observed | 1989<br>Ave./<br>station | 1988<br>Ave./<br>station | Trend in<br>Ave.<br>89-88 |
|----------------------------|-----------------|--------------------------|--------------------------|--------------------------|---------------------------|
| Tarague                    | 8               | 10                       | 1.25                     | 1.25                     | 0.00                      |
| CWA                        | 10              | 18                       | 1.80                     | 2.70                     | -0.90                     |
| NWF                        | 10              | 17                       | 1.70                     | 2.20                     | -0.50                     |
| NAVCAMS                    | 10              | 7                        | 0.70                     | 0.50                     | 0.20                      |
| Capitol Improvement Road   | 10              | 9                        | 0.90                     | 0.90                     | 0.00                      |
| MT. Santa Rosa             | 8               | 8                        | 1.00                     | 1.38                     | -0.38                     |
| Y Sengsong Road            | 10              | 9                        | 0.90                     | 0.40                     | 0.50                      |
| Two Lovers Point           | 10              | 6                        | 0.60                     | 0.40                     | 0.20                      |
| Andy South                 | 10              | 10                       | 1.00                     | 0.60                     | 0.40                      |
| Navy Golf Course Barrigada | 10              | 23                       | 2.30                     | 1.20                     | 1.10                      |
| Barrigada Hill             | 7               | 1                        | 0.14                     | 0.29                     | -0.14                     |
| Toto Pipeline              | 10              | 5                        | 0.50                     | 0.50                     | 0.00                      |
| Nimitz Hill                | 10              | 7                        | 0.70                     | 0.40                     | 0.30                      |
| Reserve Craft Beach Road   | 4               | 1                        | 0.25                     | 1.00                     | -0.75                     |
| Orote Point                | 6               | 9                        | 1.50                     | 0.50                     | 1.00                      |
| Pulantat                   | 7               | 2                        | 0.29                     | 0.50                     | -0.21                     |
| Cross Island Rd.           | 10              | 7                        | 0.70                     | 0.50                     | 0.20                      |
| NAVMAG                     | 10              | 5                        | 0.50                     | 0.70                     | -0.20                     |
| Umatac                     | 10              | 5                        | 0.50                     | 0.20                     | 0.30                      |
| Dandan                     | 10              | 4                        | 0.40                     | 0.60                     | -0.20                     |
| Ija                        | 10              | 5                        | 0.50                     | 1.50                     | -1.00                     |
| Merizo                     | 4               | 6                        | 1.50                     | 0.67                     | 0.83                      |
| Cocos Island               | 7               | 56                       | 8.00                     | 6.57                     | 1.43                      |



## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-26  
SUB-PROJECT NO.: W-2  
STUDY NO.: 2  
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam.

PERIOD COVERED: October 1, 1988 to September 30, 1989

### SUMMARY

An estimated 98 hunters spent 725 hunter days and harvested 647 birds during the January and July Black Francolin season, expending 1.19 hunter-days per bird taken. Cotal (Tarzan Falls) and Bolanos Territorial Conservation Reserves, Dandan, Ija, Pulantat, Inarajan, Nimitz Hill and other private properties were identified as areas hunted this past year. Black Francolin were found on 13 of 23 spring game bird surveys conducted throughout the island during June 1989. The average number of birds detected per station increased on 7 survey routes and decreased on 8 between 1987 and 1988. There was no statistically significant ( $P = 0.78$ ) pattern of change in the data and the differences in survey results between last year and now can be attributed to random fluctuations in local populations. Francolin occurred on 9 of the 11 survey routes in Southern Guam with the exception of Reserve Craft Beach and the Cocos Island surveys. The Merizo survey route had the highest station counts this year with an average of 9.25 birds/station. This route also had the highest relative increase in birds with the average station count increasing 2.25 birds/station. The Pulantat, Ija, Umatac, and Cross Island Road routes also had high ( $> 5.0$  birds/station) average station counts. Francolin populations are well established throughout southern Guam and appear to continue to expand their range into shrub-grass habitats in central and northern Guam, occurring on the Two Lovers survey route for the first time. This species appears able to sustain the current levels of recreational hunting.

### BACKGROUND

In 1961, 171 Black Francolin (*Francolinus francolinus*) were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4 bird daily limit and a 20 bird season limit. Francolin populations continued to increase from 1980-1982 but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population consistently increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY '83 to a 2 month-split season, 1 month in January and 1 month in July, and the bag limit was increased to 5 birds per day with no season limit. Francolin hunting has increased in

popularity and Guam hunters are successfully harvesting birds during the open seasons. Regulations implemented in FY '83 remain in effect with hunter participation and adherence to game laws monitored by spot checks by Division biologists and conservation officers.

## OBJECTIVES

To determine current relative abundance and current distribution of Black Francolin on Guam and monitor population trends and hunter harvest.

## PROCEDURES

1. Conduct annual island-wide spring game bird surveys (station counts) to monitor distribution and status of francolin throughout the island.
2. Conduct twice weekly station-count surveys during May-June to monitor pre-hunting season status of francolin population in Dandan, Inarajan.
3. Monitor hunter harvest via an annual harvest questionnaire. Collect information on hunter participation, effort, harvest, and areas hunted.

## RESULTS

### Francolin Hunting Statistics

License sales declined 9% during FY '89 with 564 sold during the year. All license holders were mailed a harvest questionnaire and responses were obtained from 136 persons (24%). Outdated or incomplete mailing addresses were a problem and 6% of the mailed questionnaires were returned as undeliverable. Of the 136 persons responding to the questionnaire, 87% indicated they had hunted at some time during the October 1 - September 31 license year. Based on that percentage, an estimated 490 persons legally hunted game during FY '89.

Twenty percent of the responding hunters reported they hunted francolin during the license year, 15% during the January season and 13% during the July season (Table 1). Hunter success was 89% in January, 80% in July and 83% for the year. The hunters that responded to our questionnaire took an average of 4.7 birds in January, 4.4 birds in July and 6.6 birds overall. Francolin hunters expended an average of 5.6, 4.5, and 7.4 days hunting in January, July, and over the entire season, respectively. Respondents report four 5-bird daily limits taken during the year.

Estimates of total hunter participation, effort, and harvest were based on hunter questionnaires. In FY '89, an estimated 98 hunters spent 725 and harvested 647 birds over the entire season. These statistics indicated a 8% increase in hunter participation, 31% increase in hunter effort, and a 11% decrease in harvest over FY '88 levels (DAWR 1988). The hunting effort expended per bird harvested was 1.19 days/bird in January, 1.02 days/bird in July, and 1.12 days/bird overall.

Although the data indicated a moderate increase in hunter activity this past season, the estimated total effort and harvest seemed far higher than actual activity and are likely over-estimates. These results reflect the bias typical of hunter questionnaires where successful hunters are far more likely to report their activities than unsuccessful ones. Consequently,

information derived from this questionnaire is more useful as an index of hunter activity rather than an absolute estimate of it.

Cotal (Tarzan Falls) and Bolanos Territorial Conservation Reserves, Dandan, Ija, Pulantat, Inarajan, Nimitz Hill and other private properties were identified as areas hunted this past year. Five hunters reported they hunted with bird dogs.

### **Spring Game Bird Surveys**

Black Francolin were again detected on 13 of 23 spring game bird surveys conducted during June 1989 (Table 2). Francolin were found on 9 of the 11 surveys south of Route 4. None were detected on the Reserve Craft Beach nor the Cocos Island survey (they have never been recorded on Cocos). For the third year in a row, francolin were located at an additional survey site north of Route 4, this year at Two Lovers Point. Francolin were found on 4 of the 12 routes in northern Guam. Although not recorded at NAVCAMS during this survey, francolin were observed there last year. Other sightings of francolin in northern Guam include one calling male in the vicinity of the tank farms on Andersen Air Force Base. These new sightings indicate that this species is continuing to increase its range in northern Guam although in small numbers only in most areas.

The Merizo survey route had the highest station counts this year with an average of 9.25 birds/station. This route also had the highest relative increase in birds with the average station count increasing 2.25 birds/station. The Pulantat, Ija, Umatac, and Cross Island Road routes also had high (> 5.0 birds/station) average station counts. The average number of birds detected per station increased on 7 survey routes and decreased on 8 between 1988 and 1989. There was no statistically significant (Wilcoxon Signed-rank Test,  $Z = -0.28$ ,  $P = 0.78$ ) pattern of change in the data and the differences in survey results between last year and now can be attributed to random fluctuations in local populations. Francolin populations remain well established and stable throughout southern Guam and appear to be continuing to expand their range into shrub-grass habitats in central and northern Guam.

### **RECOMMENDATIONS**

1. Continue to monitor francolin population status, distribution, and hunter harvest.
2. Increase the response rate of annual hunter questionnaire.

### **LITERATURE CITED**

- Division of Aquatic and Wildlife Resources. 1987. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.
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Report prepared by: Paul J. Conry

**Table 1.** Black Francolin (BLFR) harvest statistics for FY '89.

|                                                              | Jan 89 | Jul 89 | Total |
|--------------------------------------------------------------|--------|--------|-------|
| a. Total license sales for year .....                        |        |        | 564   |
| b. Hunter questionnaires mailed out.....                     |        |        | 564   |
| c. Number of hunter questionnaires returned .....            |        |        | 136   |
| d. Percent of license buyers reporting.....                  |        |        | 24%   |
| e. Number of respondents (136) that hunted any species ..... |        |        | 118   |
| f. Percent of license buyers that hunted .....               |        |        | 87%   |
| g. Estimated total number of legal hunters.....              |        |        | 490   |
| h. Number of reporting hunters that hunted BLFR .....        | 18     | 15     | 23    |
| i. Percent of reporting hunters that hunted BLFR.....        | 15%    | 13%    | 20%   |
| j. Number of successful BLFR hunters.....                    | 16     | 12     | 19    |
| k. Hunter success.....                                       | 89%    | 80%    | 83%   |
| l. Number of BLFR taken by reporting hunters.....            | 85     | 66     | 151   |
| m. Average number of BLFR taken per hunter.....              | 4.7    | 4.4    | 6.6   |
| n. Average number of BLFR taken per successful hunter.....   | 6.0    | 5.8    | 7.9   |
| o. Reported number of days spent hunting.....                | 96     | 59     | 155   |
| p. Average number of days spent hunting.....                 | 5.6    | 4.5    | 7.4   |
| q. Estimated total number of legal BLFR hunters .....        | 73     | 64     | 98    |
| r. Estimated total legal BLFR harvest.....                   | 343    | 282    | 647   |
| s. Estimated total number of days spent hunting .....        | 409    | 288    | 725   |
| t. Number of days spent hunting per BLFR taken.....          | 1.19   | 1.02   | 1.12  |
| u. Number of BLFR taken per day hunting .....                | 0.84   | 0.98   | 0.89  |
| v. Number of 5-bird daily limits.....                        | 2      | 2      | 4     |



**Table 2.** Number of Black Francolin observed per count and average number of birds observed per station as detected in spring game bird surveys at various locations on Guam during June 1989. Values in the trend column are the difference between the average station count between years.

| Survey Location            | No.<br>Stations | No.<br>Birds<br>Observed | 1989<br>Ave./<br>station | 1988<br>Ave./<br>station | Trend in<br>Average<br>89-88 |
|----------------------------|-----------------|--------------------------|--------------------------|--------------------------|------------------------------|
| Tarague                    | 8               | 0                        | 0.00                     | 0.00                     | 0.00                         |
| CWA                        | 10              | 0                        | 0.00                     | 0.00                     | 0.00                         |
| NWF                        | 10              | 0                        | 0.00                     | 0.00                     | 0.00                         |
| NAVCAMS                    | 10              | 0                        | 0.00                     | 0.10                     | -0.10                        |
| Capitol Improvement Road   | 10              | 0                        | 0.00                     | 0.00                     | 0.00                         |
| MT. Santa Rosa             | 8               | 0                        | 0.00                     | 0.00                     | 0.00                         |
| Y Sengsong Road            | 10              | 0                        | 0.00                     | 0.00                     | 0.00                         |
| Two Lovers Point           | 10              | 9                        | 0.90                     | 0.00                     | 0.90                         |
| Andy South                 | 10              | 0                        | 0.00                     | 0.00                     | 0.00                         |
| Navy Golf Course Barrigada | 10              | 38                       | 3.80                     | 2.40                     | 1.40                         |
| Barrigada Hill             | 7               | 13                       | 1.86                     | 1.00                     | 0.86                         |
| Toto Pipeline              | 8               | 1                        | 0.13                     | 0.00                     | 0.13                         |
| Nimitz Hill                | 10              | 28                       | 2.80                     | 4.50                     | -1.70                        |
| Reserve Craft Beach Road   | 4               | 0                        | 0.00                     | 0.25                     | -0.25                        |
| Orote Point                | 6               | 22                       | 3.67                     | 3.83                     | -0.17                        |
| Pulantat                   | 7               | 54                       | 7.71                     | 7.20                     | 0.51                         |
| Cross Island Rd.           | 10              | 53                       | 5.30                     | 6.20                     | -0.90                        |
| NAVMAG                     | 10              | 39                       | 3.90                     | 3.80                     | 0.10                         |
| Umatac                     | 10              | 57                       | 5.70                     | 6.10                     | -0.40                        |
| Dandan                     | 10              | 49                       | 4.90                     | 6.60                     | -1.70                        |
| Ija                        | 10              | 63                       | 6.30                     | 8.00                     | -1.70                        |
| Merizo                     | 4               | 37                       | 9.25                     | 7.00                     | 2.25                         |
| Cocos Island               | 7               | 0                        | 0.00                     | 0.00                     | 0.00                         |

# **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26  
**SUB-PROJECT NO.:** W-2  
**STUDY NO.:** 2  
**JOB NO.:** 3

**JOB TITLE:** Territory Size, Movement Patterns and Habitat Utilization of the Black Francolin.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

## **SUMMARY**

Only modest progress was made on this job during the fiscal year primarily because of a shortage of personnel. Eight solar-assisted radio transmitters and material with which to construct collars were ordered in March and received in June and July and four radio transmitter packages were assembled in August. Ten funnel traps were built and put out in the Cross Island Road area on private property and in the Cotal Conservation Reserve during September. In 210 trap days (3-weeks of continuous trapping) there was no success in trapping Francolin for this study. However, one adult male Black Francolin and one Rock Dove were killed in the traps by feral dogs. Traps will be modified in an attempt to improve trapping success.

## **BACKGROUND**

Black Francolin have been legally hunted on Guam since the first season in December 1981. With the close of the Philippine Turtle-Dove season in March 1987, the Black Francolin became the only legally hunted game bird on the island. With this new status as the sole game bird on the island has come an increased interest on the part of the Division to obtain additional data on the species in order to develop a biologically sound species management plan. An understanding of the movements, activity patterns, territory size, and habitat use is needed to evaluate population data on which the species management is based. Data on habitat use is also essential in identifying important habitats and protecting them. Such information can be obtained from radio-telemetry studies. Additional information can also be obtained on nesting habitat, nesting biology, nest survival, adult survival and causes of mortality in a radio telemetry study. All of these data will assist in the management of this species.

## **OBJECTIVES**

To determine movement patterns, territory size and habitat use of the Black Francolin.

## PROCEDURES

1. Trap and attach radio transmitters to sub-adult or adult female and male Black Francolin at a ratio of 3 females to 1 males.
2. Determine instrumented animal's movements, territory size and habitat use.
3. Develop a habitat map of the study area showing vegetation cover and current land use.
4. Find and monitor nests to collect data on nesting habitat, nesting biology, and nest survival.
5. Determine daily survival and mortality rates and causes of mortality in animals carrying radio transmitters.

## RESULTS

This project was inactive throughout most of Segment 26 because of a shortage of manpower. However, some progress was made in starting the radio-telemetry portion of this study late in the fiscal year. Eight solar-assisted radio transmitters and herculite material for the breast-mounted bib were ordered in March 1989 and received in June and July. Ten funnel traps were built and four radio transmitter packages were assembled in August. The traps were put out in September in the Cross Island Road area on private property of Mr. Antonio Quitugua and in the Cotal Conservation Reserve. Chicken scratch was used as bait and 3-weeks of continuous trapping (210 trap nights) were completed by the end of the fiscal year. The trapping efforts were without success. One adult male Black Francolin and one Rock Dove were killed in the traps by feral dogs and there was no success in trapping other francolin for this study. Pigeons were observed in the traps on a number of occasions but they managed to easily find their way out of the funnel entrance. The funnel traps were picked up at the end of the fiscal year and the funnel will be modified in an attempt to increase trapping success. The radio-telemetry portion of this job should continued during Segment 27 and data obtained during this study incorporated into the status report and species management plan (Job W-2-2-1).

## RECOMMENDATIONS

1. Modify funnel trap in an attempt to improve trapping success and continue efforts to trap and attach radio transmitters on Black Francolin.
2. Change study location to an area with higher densities of francolin if trapping success does not improve.

Report prepared by: Paul J. Conry

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: FW-2R-26  
SUB-PROJECT NO.: W-3  
STUDY NO.: 1  
JOB NO.: 1

JOB TITLE: The status and ecology of wild Asiatic water buffalo on Guam.

PERIOD COVERED: October 1, 1988 to September 30, 1989

### SUMMARY

The abundance of wild (feral) Asiatic water buffalo (*Bubalus bubalis*) on Naval Magazine showed a significant increase during FY '89. Aerial and ground surveys revealed that moderate numbers of buffalo occur outside of Naval Magazine in western Talofofo. A ratio of 42.1 calves per 100 adults was noted during daytime surveys.

### BACKGROUND

Asiatic water buffalo, known locally as carabao, were introduced to Guam in the 1600s for use as beasts of burden. Some of the island's domestic animals were reportedly let loose during World War II, resulting in the formation of a feral population in south-central Guam in the vicinity of the U.S. Naval Magazine (Anderson 1980). Research on feral water buffalo on Naval Magazine began in about 1966 when the Division of Aquatic and Wildlife Resources began to conduct spotlight counts of buffalo in conjunction with sambar deer (*Cervus unicolor*) censuses. The size of the Naval Magazine's buffalo herd remained fairly constant between 1966 and 1978, averaging about 10-13 animals recorded per 16 km traveled during counts (Anderson 1980). The population began to increase in 1979 and peaked in 1982, when a mean of 41.7 animals were noted per 16 km of counting (DAWR 1980-1982). Buffalo abundance declined thereafter, with results of counts remaining fairly constant at about 24-27 animals recorded per 16 km during the last three years (DAWR 1983-1988). In 1987, Biosystems Analysis Inc. (1989) estimated the buffalo population on the base to contain 75-150 animals. Illegal hunting appears to be the major cause of mortality in the population (Conry 1988). High buffalo densities have resulted in localized habitat damage on Naval Magazine (Conry 1988, Biosystems Analysis Inc. 1989).

### OBJECTIVES

To monitor the status of the wild Asiatic water buffalo population on Guam and to determine if control measures are necessary to maintain the population at a level compatible with the available resources.



## PROCEDURES

1. Conduct monthly spotlight counts on Naval Magazine. Analyze count data and compare with past data to estimate population trends.
2. Conduct an aerial survey of Naval Magazine and adjacent private lands to census animals located in inaccessible areas and map the population's range.
3. Conduct morning surveys of buffalo on Naval Magazine in which all animals are carefully identified by sex and age class.

## RESULTS

The average number of water buffalo seen per spotlight count on Naval Magazine increased significantly from 37.6 animals in FY '88 to 56.3 animals in FY '89 (Mann-Whitney U-Test,  $U=114.5$ ,  $P<0.01$ ) (Table 1). The mean for FY '89 corresponded to 2.5 animals seen per km, or 4.1 animals per mile, of counting. The largest number of water buffalo recorded on a monthly count increased slightly from 81 animals in FY '88 to 85 animals (twice) in FY '89.

On 24 August 1988, an air and ground survey was performed simultaneously for water buffalo on Naval Magazine and in the Bubulao and Tinechong areas of western Talofoto. Three spotters in a small airplane flew over the entire search area while a single ground observer drove around Naval Magazine. Fifty-six buffalo were seen on the base, with 35 animals noted from the ground and 21 animals from the air (Figure 1). None of these animals were recorded by both observer parties. Two herds of 15 and 26 animals were noted in western Talofoto outside of the base (Figure 1).

Several other observations of water buffalo outside of Naval Magazine were made during the year. On 2 December 1988, biologists recorded four herds of buffalo totaling 65 animals north and northeast of an area known as the "Cowboy Camp" on land owned by Mr. Joe Roberto in Bubulao (Figure 1). The largest herd contained 25 animals and was wallowing at a small reservoir on the Sarasa River. On 10 May 1989, a small group of six buffalo was noted about 1.3 km north of Talofoto Falls in the Mataitao area (Figure 1). This sighting is noteworthy because it occurred approximately 3.3 km east of Naval Magazine, which is the furthest east that feral buffalo have been recently recorded.

During four morning surveys of water buffalo on Naval Magazine in 1988 (Table 2), the following sex ratios were noted among three size classes of buffalo: 62.9 adult males per 100 adult females, 194.7 subadult males per 100 subadult females, and 96.8 male calves per 100 female calves. In these counts, an overall ratio of calves to adults averaged 42.1:100. This ratio is higher than that seen by previous observers. Anderson (1980) reported a calf:adult ratio of 16:100, whereas Biosystems Analysis Inc. (1989) noted the ratio to be 10:100.

## RECOMMENDATIONS

Continue monthly spotlight counts of water buffalo at Naval Magazine. Additional aerial and ground surveys should be conducted together, with the surveys performed early in the morning or late in the afternoon. Animals are more likely to be in open areas and visible to observers at these times of day.

An investigation into the impacts of water buffalo on Naval Magazine's vegetation should be initiated. The construction of an enclosure on the base would help to evaluate damage to

plant communities caused by browsing and wallowing. Other study activities should be expanded to obtain more biological information on diet, population characteristics, movements and general distribution, and causes of mortality.

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Report prepared by: Paul J. Conry and Gary J. Wiles

**Table 1.** Results of monthly spotlight counts of feral water buffalo at Naval Magazine, FY '89.

| Month | No.<br>animals<br>observed | Km<br>traveled | Animals/<br>km | Miles<br>traveled | Animals/<br>mile |
|-------|----------------------------|----------------|----------------|-------------------|------------------|
| Oct   | 46                         | 21.9           | 2.1            | 13.6              | 3.4              |
| Nov   | 25                         | 23.5           | 1.1            | 14.6              | 1.7              |
| Dec   | 59                         | 23.2           | 2.6            | 14.4              | 4.1              |
| Jan   | 72                         | 21.1           | 3.4            | 13.1              | 5.5              |
| Feb   | 77                         | 22.0           | 3.5            | 13.7              | 5.6              |
| Mar   | 33                         | 21.2           | 1.6            | 13.2              | 2.5              |
| Apr   | 57                         | 24.0           | 2.4            | 14.9              | 3.8              |
| May   | 85                         | 23.8           | 3.6            | 14.8              | 5.7              |
| Jun   | 43                         | 23.8           | 1.8            | 14.8              | 2.9              |
| Jul   | 47                         | 21.2           | 2.2            | 13.2              | 3.6              |
| Aug   | 47                         | 21.2           | 2.2            | 13.2              | 3.6              |
| Sep   | 85                         | 21.4           | 4.0            | 13.3              | 6.4              |
| Total | 676                        | 268.4          | 30.3           | 166.8             | 48.8             |
| Ave   | 56.3                       | 22.4           | 2.5            | 13.9              | 4.1              |
| SD    | 19.79                      |                | 9.0            |                   | 14.48            |
| CV(%) | 35                         |                | 36             |                   | 36               |

**Table 2.** Age class composition of wild water buffalo during four daytime surveys on Naval Magazine in 1988.

| Class           | 29 April | 4 May | 1 June | 8 July | Total |
|-----------------|----------|-------|--------|--------|-------|
| Adult female    | 23       | 21    | 15     | 30     | 89    |
| Subadult female | 8        | 4     | 3      | 4      | 19    |
| Female calf     | 6        | 7     | 9      | 9      | 31    |
| Adult male      | 15       | 14    | 6      | 21     | 56    |
| Subadult male   | 14       | 11    | 5      | 7      | 37    |
| Male calf       | 9        | 8     | 5      | 8      | 30    |
| Unknown         | 7        | 6     | 2      | 13     | 28    |
| Total           | 82       | 71    | 45     | 92     | 290   |

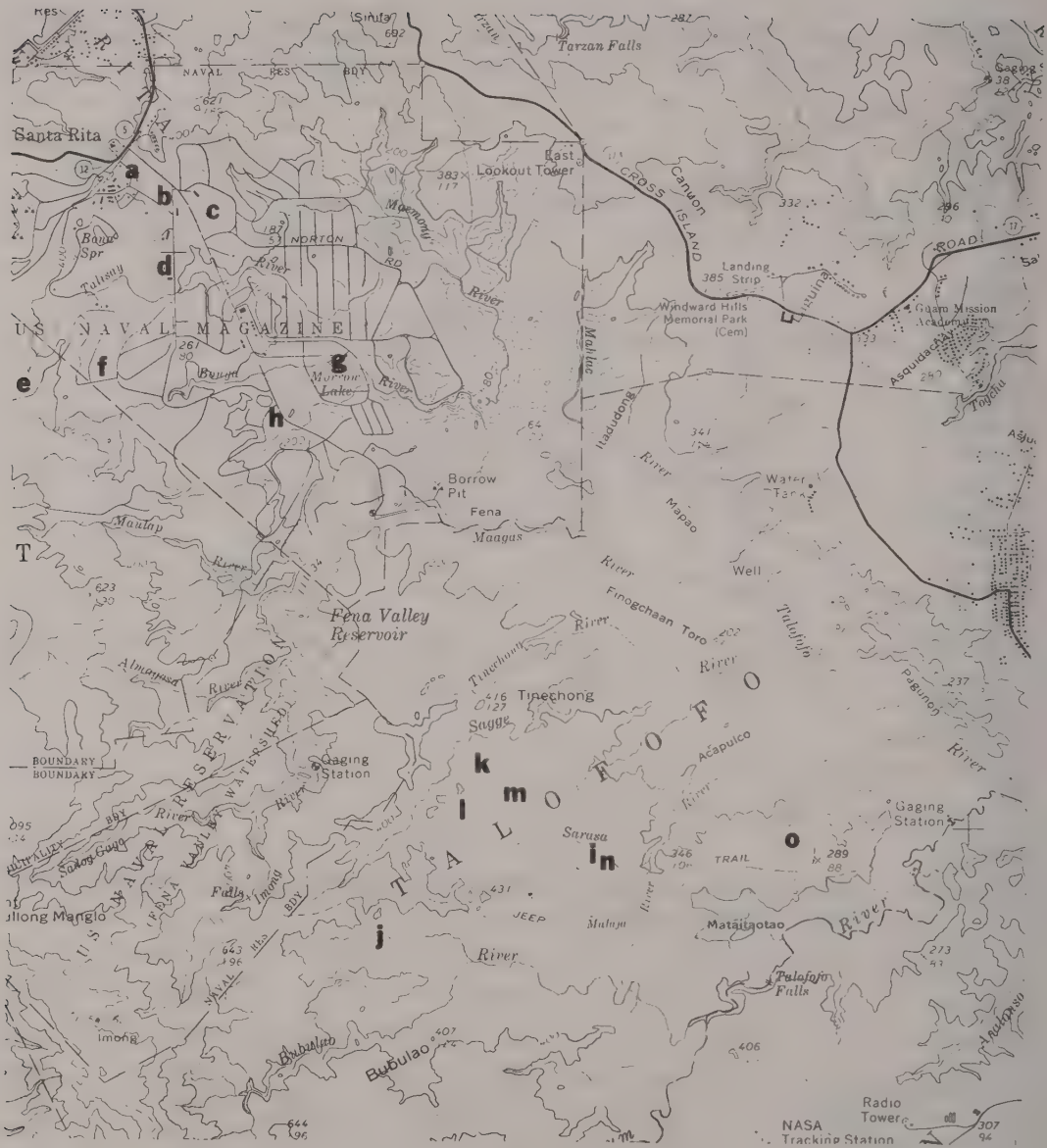


Figure 1. Noteworthy locations of wild water buffalo in southern Guam in FY '88 and FY '89. Buffalo seen during air and ground surveys are designated as follows: 24 August 1988 - (a) 4 animals, air; (b) 1 animal, ground; (c) 3 animals, air; (d) 15 animals, ground; (e) 1 animal, air; (f) 7 animals, air; (g) 6 animals, air; (h) 19 animals, ground; (i) 26 animals, air; (j) 15 animals, air; 2 December 1988 - (k, l, m) three herds totaling 41 animals, ground; (n) 25 animals, ground; and 10 May 1989 - (o) 6 animals, ground.



## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26  
**SUB-PROJECT NO.:** W-4  
**STUDY NO.:** 1  
**JOB NO.:** 3

**JOB TITLE:** Native Bird Status Surveys and Natural History.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

Roadside count data continues to document the decline of Guam's native forest birds. Introduced birds showed some increase in the North and North-Central roadside counts. Northwest Field (NWF) and Conventional Weapon Storage Area (CWSA) on Anderson Air Force Base (AAFB) remain the center of distribution for most of Guam's remaining forest birds. Guam's Island Swiftlet population increased from approximately 220 birds to 290 birds during the year. The Mariana Crow population is estimated to be less than 50 on Guam.

### **BACKGROUND**

Since the early 1960's, census data has documented the decline in both range and numbers of Guam's native land birds. Roadside counts initiated in 1960 over four routes in southern, central and northern Guam by the Guam Division of Aquatic and Wildlife Resources (DAWR) have provided an index to the decline (DAWR, 1974-1988). From 1979 to 1981 estimates of the population trends were made by the DAWR based on variable circular-plot techniques (Reynolds et al. 1980) and from station counts in central and northern Guam (DAWR 1980-1982). From June to July of 1981, an intensive forest bird survey utilizing variable-circular plot techniques along randomly located transects was conducted by the U.S. Fish and Wildlife Service with the cooperation of the DAWR (Engbring and Ramsey, 1984). Some of these transects have been repeated in recent years by the DAWR (1982-1988). In 1987, surveys for the Island Swiftlet were begun at the last known remaining nest cave located on Naval Magazine in central Guam.

Native land birds are now primarily restricted to northern Guam with the center of distribution of remaining native forest birds located on Northwest Field, Conventional Weapons Area and adjacent cliffline areas at AAFB. Exceptions are the Island Swiftlet (known only from one cave in central Guam), Mariana Common Moorhen (found over most of Guam but restricted to wetlands), Micronesian Starling (found on Cocos Island, southeast coast and various urban areas), and the Yellow Bittern (declining but found in savannah and second-growth vegetation over the entire island) (DAWR 1974-1988).

Predation by the brown tree snake, *Boiga irregularis*, is believed to be the major factor contributing to recent declines in Guam's native bird populations (Conry 1988; Savidge 1986, 1987).

A captive breeding program for the Guam Rail and Guam subspecies of the Micronesian Kingfisher was successfully begun in 1983 on Guam and at mainland U.S. zoos in cooperation with the American Association of Zoological Parks and Aquariums (DAWR 1984-1988; Derrickson 1986; Shelton 1986).

## OBJECTIVES

To continue status surveys and natural history studies as called for in the Recovery Plans for Guam's various endangered native birds.

## PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1) by DAWR Conservation Officers. These routes were driven at approximately 6-9 km per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.
2. Monthly counts of Island Swiftlets were conducted at the swiftlet cave near Firebreak 4 on Naval Magazine. Observers sat at both entrances of the cave for a period of 2-2.5 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the cave was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. Prior to each count, observers entered the cave for 0.5-1 hour to look for evidence of nesting and reproductive activity. The presence of nestlings and their calls and the incidence of adult birds that appeared to be incubating eggs or brooding young was noted. In order to avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by lifting a mirror up to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen from nests overhead.

## RESULTS

Roadside counts done on the North, North-Central and Northwest Field routes in northern Guam (Figure 1) continued to document the status of native forest birds. Tables 1, 3 and 5 contain the data collected monthly during FY '89. Table 7 is a summary of the entire fiscal year's data for all three routes. Tables 2, 4 and 6 contain a comparison of FY '89 with the previous five years data for each roadside count route.

On the North roadside count (Table 1), 9 species were counted as compared to 5 species during FY '88. Only two native forest birds, the Mariana Crow and Micronesian Starling were observed this FY whereas no native forest birds were observed in FY '88. This is the first observation for both of these species on this roadside count route since FY '86 (Table 2). The Black Francolin, originally introduced to Southern Guam in 1961, was observed for the first time on this route. Black Drongos and Yellow Bitterns continued to decline (Table 2). Eurasian Tree Sparrows continued to show an increase begun in FY '87. Philippine Turtle Doves have remained relatively level over the past 5 years.



Figure 1- Map of Guam showing the locations of Roadside Counts and the single known Island Swiftlet Cave.

**Table 1.** Average number of birds per 100 Km observed each month on the North roadside counts during FY '89.

| Species                    | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total | X/Count | X/100 Km |
|----------------------------|------|------|------|------|------|------|------|-----|------|------|------|-------|-------|---------|----------|
| Yellow Bittern             |      |      |      |      |      | 1    | 1    | 1   |      | 1    |      |       | 4     | 0.17    | 0.45     |
| Mariana Crow               |      |      |      |      |      |      |      |     |      |      |      |       | 2     | 0.09    | 0.22     |
| Black Drongo               | 10   | 6    | 1    | 1    | 6    | 8    | 4    | 10  | 2    | 9    | 4    | 4     | 65    | 2.83    | 7.23     |
| Rufous-fronted Fantail     |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Mariana Fruit-Dove         |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Guam Broadbill             |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Golden Plover              | 114  | 126  | 71   | 91   | 68   | 83   | 67   | 3   | 5    |      |      | 12    | 640   | 27.83   | 71.21    |
| White-throated Ground-Dove |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Cardinal Honeyeater        |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Micronesian Kingfisher     |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Noddy Tern                 |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| P.T. Dove                  | 12   | 2    | 1    | 8    | 4    | 24   | 1    | 4   | 8    | 2    | 4    | 3     | 73    | 3.17    | 8.12     |
| Chinese Painted Quail      |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Guam Rail                  |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Chestnut Mannikin          |      |      |      |      |      | 2    |      |     |      | 2    |      |       | 4     | 0.17    | 0.45     |
| Eurasian Tree Sparrow      | 64   | 15   | 5    | 7    |      | 10   | 6    | 4   | 7    | 2    | 1    |       | 121   | 5.26    | 13.46    |
| Micronesian Starling       |      |      |      |      |      |      |      |     |      |      | 1    |       | 1     | 0.04    | 0.11     |
| White Tern                 |      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Black Francolin            |      |      |      |      |      |      | 1    | 3   | 4    |      |      |       | 8     | 0.35    | 0.89     |
| Km                         | 82   | 79   | 87   | 90   | 38   | 121  | 57   | 82  | 75   | 76   | 77   | 35    | 899   |         |          |
| Miles                      | 51   | 49   | 54   | 56   | 24   | 75   | 26   | 51  | 47   | 47   | 48   | 22    | 549   |         |          |
| Counts                     | 2    | 2    | 2    | 2    | 1    | 3    | 1    | 2   | 2    | 2    | 2    | 1     | 22    |         |          |

**Table 2.** Average number of birds per 100 Km observed each fiscal year on the North roadside counts between 1984 and 1989.

| Species                    | FY '84 | FY '85 | FY '86 | FY '87 | FY '88 | FY '89 |
|----------------------------|--------|--------|--------|--------|--------|--------|
| Yellow Bittern             | 4.20   | 2.30   | 2.06   | 2.41   | 1.95   | 0.45   |
| Mariana Crow               | 0.30   | 0.40   | 0.10   |        |        | 0.23   |
| Black Drongo               | 23.70  | 12.20  | 13.22  | 10.35  | 9.85   | 7.23   |
| Rufous-fronted Fantail     |        |        |        |        |        |        |
| Mariana Fruit-Dove         |        |        |        |        |        |        |
| Guam Broadbill             |        |        |        |        |        |        |
| Golden Plover              | 66.00  | 49.10  | 65.12  | 54.06  | 55.67  | 71.21  |
| White-throated Ground-Dove |        |        | 0.20   |        |        |        |
| Cardinal Honeyeater        |        | 0.10   |        |        |        |        |
| Micronesian Kingfisher     |        | 0.10   |        |        |        |        |
| Noddy Tern                 |        |        |        |        |        |        |
| P.T. Dove                  | 9.90   | 6.30   | 8.13   | 9.27   | 10.19  | 8.13   |
| Chinese Painted Quail      |        |        |        |        |        |        |
| Guam Rail                  |        |        |        |        |        |        |
| Chestnut Mannikin          |        |        |        |        |        | 0.45   |
| Eurasian Tree Sparrow      | 6.60   | 5.00   | 8.91   | 7.59   | 9.85   | 13.45  |
| Micronesian Starling       |        |        | 0.88   |        |        | 0.11   |
| Bridled White Eye          |        |        |        |        |        |        |
| White Tern                 |        | 0.50   |        | 0.36   |        |        |
| Black Francolin            |        |        |        |        |        | 0.89   |

Eight species were observed on the North-Central count (Table 3). Two, the Yellow Bittern and White Tern, are native; another, the Pacific Golden Plover, is migratory; and the other five, the Black Drongo, Philippine Turtle-Dove, the Chestnut Mannikin, the Eurasian Tree Sparrow and the Black Francolin, are introduced residents. The five year data shown on Table 4 found the Black Francolin first observed on this route last year, increasing, the Chestnut Mannikin holding steady, while all other native birds declined presumably due to predation by the brown tree snake. The mannikin appears to be holding steady, both the Philippine Turtle Dove and the Eurasean Tree Sparrow appear to be continuing their slow but steady decline.

**Table 3.** Average number of birds per 100 Km observed each month on the North-Central roadside counts during FY '89.

| Species                    | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total | X/Count | X/10 |
|----------------------------|------|------|------|------|------|------|------|-----|------|------|------|-------|-------|---------|------|
| Yellow Bittern             | 3    | 5    |      |      |      |      |      |     |      |      | 2    | 1     | 11    | 0.44    | 2.   |
| Mariana Crow               |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Black Drongo               | 14   | 16   | 4    | 15   | 12   | 3    | 8    | 9   | 8    | 16   | 2    | 12    | 119   | 4.76    | 24.  |
| Rufous-fronted Fantail     |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Mariana Fruit-Dove         |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Guam Broadbill             |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Golden Plover              | 106  | 338  | 186  | 302  | 103  | 125  | 110  |     |      |      |      | 133   | 1403  | 56.12   | 289. |
| White-throated Ground-Dove |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Cardinal Honeyeater        |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Micronesian Kingfisher     |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Noddy Tern                 |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| P.T. Dove                  | 15   | 33   | 3    | 7    | 7    | 13   | 4    | 12  | 10   | 9    | 5    | 2     | 120   | 4.80    | 24.  |
| Chinese Painted Quail      |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Guam Rail                  |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| Chestnut Mannikin          |      |      |      |      |      |      | 7    |     |      |      | 3    | 1     | 11    | 0.44    | 2.   |
| Eurasian Tree Sparrow      | 6    | 5    | 2    | 9    | 4    | 5    | 2    |     |      | 4    |      |       | 37    | 1.48    | 7.   |
| Micronesian Starling       |      |      |      |      |      |      |      |     |      |      |      |       |       |         |      |
| White Tern                 |      |      |      |      |      |      |      | 1   |      |      |      |       | 1     | 0.04    | 0.   |
| Black Francolin            | 3    |      |      |      | 8    | 5    | 7    | 9   | 10   | 4    | 12   |       | 58    | 2.32    | 11.  |
| Km                         | 37   | 36   | 36   | 58   | 20   | 60   | 39   | 40  | 38   | 41   | 38   | 38    | 484   |         |      |



**Table 4.** Average number of birds per 100 Km observed each fiscal year on the North-Central roadside counts between 1984 and 1989.

| North Central: Ave./100km  | FY '84 | FY '85 | FY '86 | FY '87 | FY '88 | FY '89 |
|----------------------------|--------|--------|--------|--------|--------|--------|
| Yellow Bittern             | 6.70   | 2.40   | 3.22   | 5.04   | 3.10   | 2.27   |
| Mariana Crow               | 2.00   |        | 0.76   | 0.88   |        |        |
| Black Drongo               | 44.38  | 30.90  | 25.57  | 22.14  | 26.14  | 24.57  |
| Rufous-fronted Fantail     | 0.40   |        |        |        |        |        |
| Mariana Fruit-Dove         | 0.20   |        |        |        |        |        |
| Guam Broadbill             |        |        |        |        |        |        |
| Golden Plover              | 362.69 | 240.80 | 483.27 | 437.92 | 397.40 | 289.72 |
| White-throated Ground-Dove |        |        |        |        |        |        |
| Cardinal Honeyeater        | 0.40   |        |        |        |        |        |
| Micronesian Kingfisher     | 1.10   |        |        |        |        |        |
| Noddy Tern                 |        |        |        |        |        |        |
| P.T. Dove                  | 34.90  | 39.00  | 37.89  | 37.26  | 35.89  | 24.78  |
| Chinese Painted Quail      |        |        |        |        |        |        |
| Guam Rail                  |        |        |        |        |        |        |
| Chestnut Mannikin          | 1.30   | 0.80   |        | 3.29   | 1.77   | 2.27   |
| Eurasian Tree Sparrow      | 13.90  | 22.90  | 36.75  | 13.59  | 17.50  | 7.64   |
| Micronesian Starling       | 1.30   | 1.30   |        |        |        |        |
| Bridled White Eye          |        |        |        |        |        |        |
| White Tern                 | 1.80   | 1.80   |        | 1.53   |        | 0.21   |
| Black Francolin            |        |        |        |        | 9.75   | 11.98  |

On the Northwest Field Roadside Count (Tables 5 and 6), only one native forest bird, the Mariana Crow, was observed during FY '89. It showed a slight increase, reversing for the first time in 5 years its gradual decline (Table 6). No Micronesian Kingfishers were observed on this route, the first time since the count began. The only other native bird observed was the Yellow Bittern. Table 6, the six-year summary, documented the continuing 6 year decline of the introduced Philippine Turtle Dove, Eurasian Tree Sparrow and Black Drongo. Numbers of the migratory Pacific Golden Plover have continued to increase in recent years.

**Table 5.** Average number of birds per 100 Km observed each month on the Northwest Field roadside counts during FY '89.

| Species                    | Oct. | Nov. | Dec. | Jan. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total | X/Count | X/100 Km |
|----------------------------|------|------|------|------|------|------|-----|------|------|------|-------|-------|---------|----------|
| Yellow Bittern             |      | 2    | 3    | 3    | 1    | 2    | 2   | 5    |      | 1    |       | 19    | 0.86    | 4.73     |
| Mariana Crow               | 13   | 11   | 5    | 9    | 2    | 2    | 7   | 2    | 4    |      |       | 55    | 2.50    | 13.68    |
| Black Drongo               | 27   | 7    | 19   | 11   | 26   | 29   | 21  | 29   | 13   | 25   | 12    | 219   | 9.95    | 54.48    |
| Rufous-fronted Fantail     |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Mariana Fruit-Dove         |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Guam Broadbill             |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Golden Plover              | 44   | 101  | 116  | 99   | 103  | 70   |     |      |      | 18   | 52    | 603   | 27.41   | 149.99   |
| White-throated Ground-Dove |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Cardinal Honeyeater        |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Micronesian Kingfisher     |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Noddy Tern                 |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| P.T. Dove                  | 20   | 15   | 11   | 17   | 13   | 14   | 24  | 22   | 6    | 16   | 10    | 168   | 7.64    | 41.79    |
| Chinese Painted Quail      |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Guam Rail                  |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Chestnut Mannikin          |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Eurasian Tree Sparrow      |      |      |      | 4    | 2    |      |     |      |      |      |       | 6     | 0.27    | 1.49     |
| Micronesian Starling       |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| White Tern                 |      |      |      |      |      |      |     |      |      |      |       |       |         |          |
| Km                         | 36   | 36   | 38   | 55   | 54   | 37   | 37  | 37   | 18   | 35   | 18    | 402   |         |          |
| Miles                      | 22   | 23   | 23   | 34   | 34   | 23   | 23  | 23   | 11   | 22   | 11    | 250   |         |          |
| Counts                     | 2    | 2    | 2    | 3    | 3    | 2    | 2   | 2    | 1    | 2    | 1     | 22    |         |          |

**Table 6.** Average number of birds per 100 Km observed each fiscal year on the Northwest Field roadside counts between 1984 and 1988.

| Species                    | FY '84 | FY '85 | FY '86 | FY '87 | FY '88 | FY '89 |
|----------------------------|--------|--------|--------|--------|--------|--------|
| Yellow Bittern             | 9.90   | 3.70   | 11.62  | 4.69   | 2.72   | 4.73   |
| Mariana Crow               | 32.50  | 28.60  | 19.44  | 13.85  | 10.90  | 13.68  |
| Black Drongo               | 439.10 | 369.00 | 282.64 | 115.96 | 71.82  | 54.48  |
| Rufous-fronted Fantail     | 2.70   |        |        |        |        |        |
| Mariana Fruit-Dove         | 2.70   | 0.60   |        |        |        |        |
| Guam Broadbill             |        |        |        |        |        |        |
| Golden Plover              | 51.60  | 17.40  | 88.26  | 101.66 | 114.91 | 149.99 |
| White-throated Ground-Dove | 1.70   | 0.60   | 2.68   |        |        |        |
| Cardinal Honeyeater        | 8.90   |        |        |        |        |        |
| Micronesian Kingfisher     | 9.50   | 4.60   | 1.12   | 0.45   | 0.25   |        |
| Noddy Tern                 |        |        |        |        |        |        |
| P.T. Dove                  | 175.23 | 159.90 | 123.11 | 81.11  | 60.88  | 41.79  |
| Chinese Painted Quail      |        |        |        |        |        |        |
| Guam Rail                  | 0.30   | 0.30   | 0.22   |        |        |        |
| Chestnut Mannikin          | 2.00   | 0.90   | 1.34   |        |        |        |
| Eurasian Tree Sparrow      | 8.20   | 0.30   | 5.36   | 2.46   |        | 1.49   |
| Micronesian Starling       | 20.40  | 6.00   | 2.01   |        |        |        |
| Bridled White Eye          |        |        |        |        |        |        |
| White Tern                 | 0.70   | 1.40   | 0.89   |        |        |        |
| Black Francolin            |        |        |        |        |        |        |

**Table 7.** Results of Northwest Field, North, and North-Central roadside counts showing the mean number of birds per 100 Km of travel, the standard deviation (St.Dev.) and the coefficient of variation (CV).

| Species                    | Northwest Field |          |       | North    |          |        | North Central |          |       |
|----------------------------|-----------------|----------|-------|----------|----------|--------|---------------|----------|-------|
|                            | X/100 Km        | St. Dev. | CV    | X/100 Km | St. Dev. | CV     | X/100 Km      | St. Dev. | CV    |
| Yellow Bittern             | 4.73            | 1.08     | 22.90 | 0.45     | 0.39     | 87.07  | 2.27          | 1.19     | 52.52 |
| Mariana Crow               | 13.68           | 3.36     | 24.58 | 0.22     | 0.42     | 187.39 |               |          |       |
| Black Drongo               | 54.48           | 5.37     | 9.85  | 7.23     | 2.66     | 36.74  | 24.57         | 3.85     | 15.69 |
| Rufous-fronted Fantail     |                 |          |       |          |          |        |               |          |       |
| Mariana Fruit-Dove         |                 |          |       |          |          |        |               |          |       |
| Guam Broadbill             |                 |          |       |          |          |        |               |          |       |
| Golden Plover              | 149.99          | 23.44    | 15.63 | 71.21    | 26.36    | 37.02  | 289.72        | 55.17    | 19.04 |
| White-throated Ground-Dove |                 |          |       |          |          |        |               |          |       |
| Cardinal Honeyeater        |                 |          |       |          |          |        |               |          |       |
| Micronesian Kingfisher     |                 |          |       |          |          |        |               |          |       |
| Noddy Tern                 |                 |          |       |          |          |        |               |          |       |
| P.T. Dove                  | 41.79           | 3.84     | 9.18  | 8.12     | 3.14     | 38.69  | 24.78         | 4.80     | 19.39 |
| Chinese Painted Quail      |                 |          |       |          |          |        |               |          |       |
| Guam Rail                  |                 |          |       |          |          |        |               |          |       |
| Chestnut Mannikin          |                 |          |       | 0.45     | 0.58     | 129.46 | 2.27          | 1.50     | 66.13 |
| Eurasian Tree Sparrow      | 1.49            | 0.94     | 62.66 | 13.46    | 12.26    | 91.05  | 7.64          | 1.87     | 24.52 |
| Micronesian Starling       |                 |          |       | 0.11     | 0.21     | 187.39 |               |          |       |
| White Tern                 |                 |          |       |          |          |        | 0.21          | 0.20     | 96.85 |
| Black Francolin            |                 |          |       | 0.89     | 0.88     | 99.38  | 11.98         | 3.22     | 26.92 |

Roadside census work and observations made incidental to Philippine Turtle-Dove counts (DAWR 1989) and Mariana Crow nest snakeproofing (DAWR 1989) suggest that NWF and CWSA on AAFB remain the center of distribution for most of Guam's remaining native forest avifauna.

The numbers of Island Swiftlets counted during monthly censuses at the Firebreak 4 Cave on Naval Magazine increased from about 220 birds to about 290 birds during FY '89 (Table 8). Excluding two counts (late May and early September) that were unreasonably high and probably in error, census results showed a gradual increase in swiftlet numbers after January. This corresponds well with the extended peak in the breeding season, which

in previous years, has begun approximately in February and continued until about August (DAWR 1987-1988). The gradual nature of the population increase suggests that it was due to natural recruitment from birds residing within the cave, rather than from the immigration of new birds from other unknown caves. At present, the Firebreak 4 Cave continues to be the only active swiftlet cave known on Guam. The increase in the swiftlet population is extremely encouraging and shows that the population is recovering from the sudden decline that occurred in June and July 1988, when bird numbers fell by almost 60% (DAWR 1988).

**Table 8.** Results of censuses for Island Swiftlets at the Firebreak 4 Cave on Naval Magazine during FY '89. Evidence of reproductive activities of swiftlets is also presented.

| Date        | Net No. of Birds Cave Entering Cave | No. of Birds Estimated in at Start of Count | Total No. of Birds Counted | Reproductive Parameters               |                                               |                        |                       |                                 |
|-------------|-------------------------------------|---------------------------------------------|----------------------------|---------------------------------------|-----------------------------------------------|------------------------|-----------------------|---------------------------------|
|             |                                     |                                             |                            | No. of Whole Eggs Found on Cave Floor | No. of Eggshell Fragments Found on Cave Floor | No. of Nestlings Heard | No. of Nestlings Seen | Incubation or Brooding Observed |
| 24 Oct 1988 | 209                                 | 10                                          | 219                        | 0                                     | 4                                             | 2                      | 0                     | undetermined                    |
| 22 Nov      | 227                                 | 3                                           | 230                        | 0                                     | 1                                             | 1                      | 1                     | no                              |
| 3 Jan 1989  | 214                                 | 7                                           | 221                        | 2                                     | 4                                             | 3-4                    | 2                     | undetermined                    |
| 31 Jan      | 197                                 | 31                                          | 228                        | 0                                     | 7                                             | 3-4                    | 1                     | undetermined                    |
| 1 March     | 168                                 | 76                                          | 244                        | 3                                     | 14                                            | 4+                     | 6+                    | yes                             |
| 28 March    | 192                                 | 32                                          | 224                        | 3                                     | 12                                            | 2-3                    | 3                     | undetermined                    |
| 2 May       | 206                                 | 34                                          | 240                        | 6                                     | 18                                            | 3-4                    | 4                     | undetermined                    |
| 30 May      | 264                                 | 49                                          | 313                        | 1                                     | 14                                            | 2-3                    | 4                     | undetermined                    |
| 28 June     | 232                                 | 41                                          | 273                        | 4                                     | 11                                            | 2                      | 2                     | undetermined                    |
| 2 Aug       | 252                                 | 25                                          | 277                        | 1                                     | 13                                            | 3-4                    | 1                     | undetermined                    |
| 5 Sept      | 290                                 | 19                                          | 309                        | 2                                     | 8                                             | several                | 1                     | undetermined                    |
| 27 Sept     | 276                                 | 16                                          | 292                        | 2                                     | 10                                            | 2                      | 3                     | undetermined                    |

Reproductive indicators continued to be recorded in FY '89 and agreed fairly closely with data collected in 1987 and 1988 (DAWR 1987-1988). Evidence of breeding was found year-round, although most activity was noted from February to September (Table 8).

Low to moderate numbers of snake tracks were found on the surface of guano deposits on the cave floor in 10 of the 12 visits to the cave. In early January, a snake (MJM 693; snout-vent length = 986 mm) was captured in the cave at 1625 h as it crawled along the edge of the floor below a section of active swiftlet nests. It has not yet been necropsied for analysis of stomach contents. A second snake (MJM 847; snout-vent length = 1,410 mm) was found crawling across a vertical limestone rock face about 40-50 m south of the cave at about 0900 h on 28 March. Its stomach was empty. Several feces-like clumps of swiftlet feathers were collected from the floor of the cave during the year. These may have been snake droppings but an exact identification has not yet been made.

Several development projects were proposed for the Talofofo River valley by the territorial government and foreign developers during the year. Because of concern that the projects might adversely impact swiftlets residing at the Firebreak 4 cave, a survey was conducted to learn more about the foraging range and behavior of the birds from this colony. The study was made in the Talofofo and lower Ugum River valleys, where most feeding was suspected, based on previous anecdotal sightings of swiftlets over the previous six years. During the survey, observations for birds were made from 52 stations widely distributed in both valleys. Stations were placed at locations that provided views of large areas of forest

canopy and grassland. Counts were performed twice at each station for one hour each time and were usually done 4-7 weeks apart. Most observations (96 stations) were conducted from 4 April to 28 June but an additional eight stations were made from 19-25 September.

Results of the study showed that swiftlets foraged over the entire length of the Talofofo Valley from eastern Naval Magazine to Talofofo Bay (Figure 2). Swiftlets were seen on 47 of the 104 stations. Most sightings occurred north of the Talofofo and Maagas Rivers, with some additional sightings made in the Asalonso region of Malojloj. Birds were seen up to 6 km from the Firebreak 4 cave. Most foraging occurred in an area within 1 km from the colony's cave on Naval Magazine and in a second area along the Pagunon stream valley immediately southwest of Talofofo village. Flocks of up to 40 or more birds were seen several times in the Pagunon area. Many of the swiftlet sightings made in the Mapao region of the valley were of solitary birds that appeared to be commuting between the cave and Pagunon. Their flight was generally rapid and direct with little or no feeding observed. Overall, the pattern of sightings may be related to aerial insect abundance. Interestingly, the pattern closely matches the existing distribution of limestone substrates in the valley. Insect abundance may be greater over limestone soils than volcanic soils.

## RECOMMENDATIONS

1. Continue bi-monthly roadside counts over the three routes in northern Guam.
2. Continue census of the Guam Rail in areas where appropriate.
3. Continue to census the Mariana Crow in order to estimate population size and distribution on Guam.
4. Continue breeding biology studies and attempts to snake proof nest sites of the Mariana Crow on Guam.
5. Continue monthly cave censuses and efforts to assess population change and reproductive activity of Island Swiftlets.
6. Consider snake-proofing the Firebreak 4 Cave used by swiftlets.
7. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofofo River valley about the use of pesticides on their farms.
8. Develop and implement methods for control of the brown tree snake.
9. Continue efforts to captive breed endemic endangered native land birds on Guam and at stateside zoos.
10. Implement plans to translocate captive bred Guam Rails to Rota, C.N.M.I. for purposes of establishing a wild population in a snake-free environment.





Figure 2. Distribution of Island Swiftlet sightings during a survey conducted in the Talofoto and lower Ugum River valleys. Two counts were made at each of 52 stations. All counts were conducted from 4 April to 28 June 1989 except for eight counts (designated with an "A") that were performed from 19-25 September 1989. The location of the Firebreak 4 Cave is designated with a large "X"; the general boundary of the Talofoto River valley is demarcated by the heavy black line.

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Report prepared by: Robert E. Beck, Jr. and Gary J. Wiles.

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** W-5

**STUDY NO.:** 1

**JOB NO.:** 2

**JOB TITLE:** Natural History, Biology, and Habitat Protection for the Marianas Fruit Bats.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### SUMMARY

Guam's fruit bat population is currently estimated at 425 to 510 animals, which is a decline of approximately 75-100 bats from the previous year. Bat colonies used two roosts on Pati Point during the year. Fecal analysis studies revealed that *Neisosperma oppositifolia*, *Cycas circinalis*, *Pandanus tectorius*, *Artocarpus* sp., and *Mammea odorata* are important bat foods. A low incidence of young bats was again noted on Guam in early FY '89, in contrast to observations made on Rota. Evidence of inter-island movements by fruit bats within the Mariana Islands was reviewed and summarized in a report for publication. One suspected case of illegal hunting of fruit bats occurred during the year. In FY '89, 16,664 frozen fruit bats were imported to Guam from other islands for human consumption, an increase of 22.6% from the previous year. Assistance was given to the CNMI Division of Fish and Wildlife during a week-long census of bats on Rota in November.

### BACKGROUND

The Marianas fruit bat (*Pteropus mariannus mariannus*) is endemic to the Mariana Islands and has been under investigation by the Guam Division of Aquatic and Wildlife Resources (DAWR) since 1962 (DAWR 1964-1988). These bats, considered a delicacy by Chamorro residents, steadily declined in number during the 1960's (Perez 1972). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in suitable habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increased human population pressures that resulted in overhunting and permanent habitat destruction, commercial exploitation of bats as a food, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). The Marianas fruit bat and the little Marianas fruit bat (*P. tokudae*) finally received full protection from hunting in 1973. Both species were placed on Guam's territorial Endangered Species List in 1981 and on the U.S. Endangered Species List in August 1984, but *P. tokudae* is now thought to be extinct. The island's population of Marianas fruit bats grew substantially to an estimated 850 - 1,000 animals between 1980 and 1982, probably from immigration of bats from Rota (Wiles 1987a). However, numbers have declined since 1983 because of continued illegal hunting and suspected predation on bats by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b). Guam's fruit bat population was estimated at 500-600 animals in FY '88 (DAWR 1988).

## OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as called for in the Fruit Bat Recovery Plan.

## PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) as initiated in the late 1970's.
  - a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.
  - b. Conduct monthly censuses at known bat colonies on Guam.
  - c. Assist the CNMI Division of Fish and Wildlife (CNMIDFW) with surveys of fruit bats on other islands as needed.
2. Record information on the behavior and reproduction of fruit bats in colonies.
3. Determine habitat use of fruit bats. Visit abandoned roost colonies and record information about terrain and the size and abundance of vegetation present.
4. Monitor fruit bat imports to Guam from other islands in Micronesia and the Pacific.
5. Investigate illegal hunting of fruit bats on Guam.
  - a. Visit abandoned roosting sites of colonies to determine illegal hunting effort.
  - b. Assist Conservation Officers with investigations of bat poaching.

## RESULTS

### Locations of Bat Colonies on Guam

Fruit bats roosted at two known sites on Pati Point during FY '89 (Figure 1). Roost 1 was occupied for more than 11 months of the year while Roost 15 was used briefly at the start of the fiscal year (Table 1). Roost 1 has been inhabited extensively in previous years (DAWR 1987). In early December, an agricultural extension agent reportedly observed a group of about 10 bats flying during the morning behind the golf course at Lafac Point on AAFB, suggesting that a small colony may have roosted temporarily in this area. Two follow-up surveys did not locate any bats there.

As in previous years, attempts were made to determine the causes of colonies moving to new roosting sites. Roost 1 was abandoned in early October during a period when the weather was rainy and overcast for several days and winds were blowing from the south and southeast. Unusual winds have been suspected of causing movements between roosting sites on Pati Point in the past (DAWR 1988). Roost 15 was disturbed by me when winds suddenly shifted and blew my odor to the colony during reproductive observations on 27 October. Approximately half of the colony moved immediately to



Roost 1 during this disturbance, with the remainder of the colony shifting there within about a week.

### Survey of Fruit Bats on Guam

Censuses of fruit bats at colonies varied substantially during the year, ranging from 271 to 553 animals (Table 2). Counts were highest in December and January, when 550 and 553 bats were censused, respectively. The variation in counts may have resulted from inter-colonial movements between the main roost and other smaller undiscovered roosts on the island, or from inter-island movements between Guam and Rota. Several searches for additional bat colonies were conducted during the year in the vicinity of Pati Point and elsewhere on AAFB but did not find any roosts. These searches were not exhaustive and small colonies, such as the one that possibly occurred at Lafac Point (see above), could have gone undiscovered. Detailed censuses of fruit bats were not conducted on Rota during FY'89, making it impossible to detect changes in that island's bat population and verify movements.

An estimate of the island's population of fruit bats at the end of FY '88 was determined using the early October 1989 count of 320 bats at Roost 1. Because some individuals were probably hidden by thick foliage during that count, the total number of adults in the colony was likely to be 10 to 20% higher than the actual number recorded. In addition, based on previous observations (DAWR 1985), approximately 65% of the adults in the colonies were harem females. An estimated 10% of these animals probably possessed unweaned young. These figures provide an estimate of 352 to 384 adults and 23 to 25 juveniles, or a total of 375 to 409 bats, on Pati Point during late September and early October 1989.

A survey made specifically for fruit bats was performed in the Northwest Field-Ritidian Point area during 13-21 October. Counts were conducted twice at each of 11 stations. Counts lasted 45 min each and were made between 0620 and 0815. Six to eight bats were recorded in the survey, all of which were seen or heard along the cliffline west and northwest of Mt. Machanao. Solitary bats were seen on two of five surveys made for common moorhens during the year at Fena Lake at Naval Magazine. Finally, between 4 April and 25 September, 104 hours of observations for island swiftlets (*Aerodramus vanikorensis*) at 52 stations were performed in the Tafofoto and Ugum River valleys. The counts were made between 0830 and 1400, a period of day which is generally poor for viewing fruit bats. No bats were seen during this study.

Incidental daytime sightings of single fruit bats were made during the year in the Conventional Weapons Storage Area on AAFB (1 sighting), at Lafac Point (1 sighting), at NAVCAMS about 600 m northwest of the base's main entrance (1 sighting), at Mt. Barrigada (1 sighting), along the cliffline at Fadian Point (2 sightings), and, as noted above, over the southern half of Fena Lake (2 sightings). Nighttime sightings of bats occurred along the Tarague cliffline at AAFB (1 sighting), at Mt. Barrigada (1 sighting), at Talofofo Bay (1 sighting), and at Cocos Island (1 sighting).

Excluding bats residing in the colony at Pati Point, an estimated 25 to 50 fruit bats are still believed to live solitarily or in small groups along the island's northern cliffline that extends from Bijia Point to Iates Point. An additional 25 to 50 animals probably inhabit Naval Magazine and other forested areas in southern Guam. Based on these figures, Guam's island-wide population of fruit bats at the end of FY '89 was estimated to contain 425 to 510 animals. This number is reduced from the FY '88 estimate of 500 to 600 animals (DAWR 1988).

## Survey of Fruit Bats on Rota

The DAWR assisted the CNMIDFW in FY '89 with a survey of fruit bats on Rota from 31 October to 4 November. Two bat colonies were found during the survey, however, accurate counts of roosting bats could not be made at either site. The colony at Uzulon Hulo had moved several hundred meters east of its former location, making direct counts of bats impossible as performed in previous years. Thus, evening departure counts were used to census this roost and one located at As Puepuenge. At Uzulon Hulo, counts of 642 and 320 bats were obtained during two departure counts on separate nights, with an estimate of 600 bats made for the entire roost. About 230 bats exited the As Puepuenge colony, giving an estimate of 460 animals for that location. Solitary bats were surveyed during station counts around the island. An extrapolation of results gave an estimate of 260 extra-colonial animals island-wide. Based on all counts, a total population estimate of approximately 1,327 bats was made for Rota, which is a severe reduction from the approximately 2,300 bats estimated for the island in October 1987 (DAWR 1988).

Data on the incidence of harem females with young (see Natural History) were gathered during this survey, along with several lengthy feeding observations of bats eating seeded breadfruit (*Artocarpus mariannensis*). The information will be used by the CNMIDFW to compile a final report on the abundance and ecology of *P. mariannus* on Rota.

## Natural History

**Food Habits** - The composition of 506 fruit bat droppings was analyzed to determine food habits on a seasonal basis. Droppings were collected underneath abandoned colonial roosting sites between 1983 and 1988. Thirteen types of fruit were found in feces, however, more than half of all droppings could not be identified to a particular species (Table 3). Preliminary findings indicated that *Neisosperma oppositifolia*, *Cycas circinalis*, *Pandanus tectorius*, *Artocarpus* sp., and *Mammea odorata* were the fruits most favored. Data will be presented and discussed more thoroughly in a report to be written on the food habits of *P. mariannus*.

**Reproduction** - Monthly observations of harem females in colonies on Guam were made during the first portion of FY '89, a continuation of similar work performed in previous years (DAWR 1985-1987). The females were examined visually through a spotting scope for the presence of unweaned young. Females with young comprised 11.8 to 13.0% of the females identified in the three months that observations were conducted (Table 4). All of the juveniles observed were judged to be small-sized.

Observations of female bats were also made on Rota in November. About 29% of the females possessed young (Table 4). The relative proportions of the size classes of juveniles were: small, 70%; medium, 30%; and large, 0%. The percent of females with young was slightly lower than in October 1987, when 33.7% of the adult females were accompanied by young (DAWR 1987). These observations and those made in February after Typhoon Roy suggest that reproduction in fruit bat populations may terminate temporarily for periods of up to six months after severe typhoons.

**Inter-island Movements** - A manuscript was written by G. Wiles and P. Glass of the CNMIDFW to document recent evidence of inter-island movements by *P. mariannus* in the Marianas, based on information collected from 1978 to 1988 (Wiles and Glass, in prep.). The article, which is summarized here, has been submitted for publication. Descriptions were given for six flights of large groups of 50-300 bats between Rota and neighboring islands, with an additional six movements of one to a few bats between other islands also reported (Table 5). Hunting and other forms of human disturbance at roosts were believed

to have caused at least four of the six large group movements. Rota, which has the largest fruit bat population in the southern Marianas, was the most important source of dispersing bats in that part of island chain. Rota's bat population must receive adequate protection from illegal hunting so that it can continue to act as a source of bats for recolonizing neighboring islands, all of which have greatly reduced populations.

### **Illegal Hunting**

Poaching has long been a major cause of mortality of *P. mariannus* on Guam and other islands in the southern Marianas (Wiles 1987a, 1987b; Wiles et al. 1989). One probable case of illegal hunting was recorded on Guam in FY '89. A small (weight = 70 g, forearm = 72 mm) female baby fruit bat was turned in to the DAWR on 15 June after it was reportedly found on the ground below a large breadfruit tree in the yard of a house/ranch located within about 400 m of the main gate of AAFB. The animal was healthy but had two small partially healed holes in its wings. The holes were identical to those formed by shotgun pellets. This suggests that the bat's mother had been shot at several days to a week earlier by hunters. This incident may have been tied in with the finding of the baby.

### **Fruit Bat Imports**

During FY '89, 76,509 fruit bats were requested for import (Table 6), an increase of 48.1% from the previous year (DAWR 1988). The number of import permits issued by the DAWR increased to 884 during FY '89, a rise of 39.7% over FY '88. Approximately 43.2% of the import permits issued by the DAWR during the year had fruit bats as one of the items requested.

An estimated 16,664 frozen fruit bats in 345 shipments were actually shipped to Guam from other islands in FY '89 (Table 7). These figures represent a 22.6% increase in the estimated number of bats imported to Guam and a 8.8% increase in the number of shipments received when compared to FY '88 (DAWR 1988). Palau and Pohnpei were the major sources of fruit bats for the Guam market in FY '89, with exports of 7,532 and 6,478 animals, respectively, during the year (Table 7). These amounts represented 84.1% of the total number of bats imported to Guam. Pohnpei increased its bat shipments to Guam by 495.4% over the previous year, while exports from Palau declined by 28.8% during the year. Truk shipped 2,507 bats to Guam, making it the third largest exporter of fruit bats, and accounted for 15.0% of the import total for FY '89. This pattern in shipments continues a trend that began two years ago in which nearly all of the bats brought to Guam originated in the Caroline Islands (DAWR 1987, 1988).

No other island or country exported a significant number of fruit bats to Guam during FY '89 (Table 7). A total of 65 bats entered from Yap, of which 37 bats in two shipments were legally killed during a month-long hunting season on Ulithi Atoll in November. Also during the year, Continental Airlines initiated air service to Bali, Indonesia and Brisbane and Sydney, Australia, with the airline flying three times per week to each of those destinations. These new airline routes did not result in shipments of fruit bats arriving from either country.

During FY '89, 456 fruit bats in 49 shipments were confiscated by the Guam Customs and Quarantine Division upon entry into Guam. These figures represented 2.7% of the total number of bats brought to the island and 14.2% of the shipments received during the year. Shipments were seized for a variety of violations including lack of import permits, lack of certificates of origin, or because the bats originated from islands where they were protected by local laws. A confiscated shipment of 35 fruit bats from American Samoa contained 33 *P. tonganus* and two *P. samoensis*.



## RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota (P.O. Glass, pers. comm.) can cause large numbers of bats to move to Guam (Wiles and Glass, in prep.).
2. Continue to make observations at Guam's bat colonies. Information on reproductive biology, behavior within the colonies, and social organization will be used to supplement data already gathered.
3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.
4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.
5. Known bat roosting and foraging areas should be patrolled regularly by Conservation Officers. Part of their effort should be aimed at maintaining a visible presence at Jinapsan and Pajon Points, where poaching has been a serious problem in previous years.
6. Form a cooperative bat research program with the CNMI to collect information on the locations and sizes of colonies, reproductive biology and behavior within colonies. Most of the work done under this program would be conducted on Rota where a moderately sized bat population is found but where logistics prevent the CNMI from doing extensive fieldwork. Emphasis of this project would be to identify colonies should they move between Guam and Rota.
7. Continue to monitor fruit bat imports entering Guam. Export permits or certificates of origin should continue to be required for all shipments to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their fruit bat populations.

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Report prepared by: Gary J. Wiles

**Table 1.** Approximate dates of use of two roost sites used by colonies of Marianas fruit bats on Guam in FY '89.

| Roost number | Roost location   | Approximate periods of use by bats  |
|--------------|------------------|-------------------------------------|
| 1            | North Pati Point | 24 Sept-3 Oct 88, 27 Oct 88-present |
| 15           | North Pati Point | 18 Sept-6 Nov 88                    |

**Table 2.** Counts of Marianas fruit bats at roosts on Andersen Air Force Base, Guam in FY '89.

| Date         | Roost Number   |                |    |    |    |    |    |    |    | Total |
|--------------|----------------|----------------|----|----|----|----|----|----|----|-------|
|              | 15             | 1              | 14 | 15 | 16 | 17 | 18 | 20 | 21 |       |
| 29 Sept 1988 | 66             | 278            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 344   |
| 7 Oct        | 271            | -              | -  | -  | -  | -  | -  | -  | -  | 271   |
| 20 Oct       | +              | 0              | 0  | 0  | 0  | -  | 0  | 0  | 0  | x     |
| 26 Oct       | 310            | 0              | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 310   |
| 28 Oct       | + <sup>a</sup> | + <sup>a</sup> | -  | -  | -  | -  | -  | -  | -  | x     |
| 15 Nov       | 0              | +              | 0  | 0  | 0  | 0  | 0  | 0  | 0  | x     |
| 21 Nov       | 0              | 414            | -  | -  | -  | -  | -  | -  | -  | 414   |
| 28 Dec       | 0              | 550            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 550   |
| 23 Jan 1989  | 0              | 553            | -  | -  | -  | -  | -  | -  | -  | 553   |
| 23 Feb       | 0              | 399            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 399   |
| 27 Mar       | 0              | 427            | -  | -  | -  | -  | -  | -  | -  | 427   |
| 24 Apr       | 0              | 472            | -  | -  | -  | -  | -  | -  | -  | 472   |
| 23 May       | 0              | 339            | -  | -  | -  | -  | -  | -  | -  | 339   |
| 22 June      | 0              | 381            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 381   |
| 1 Aug        | 0              | +              | -  | -  | -  | -  | -  | -  | -  | x     |
| 24 Aug       | 0              | 340            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 340   |
| 11 Oct       | 0              | 320            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 320   |

+ = Bats present at roost but no count made; - = colony was not visited; x = no total count made.

<sup>a</sup> = Approximately equal numbers of bats were equal at both locations.

**Table 3.** Preliminary food analysis of 506 droppings of Marianas fruit bats obtained at abandoned roosts.

| Fruit                            | Dec-Feb           | March-May         | June-Aug          | Sept-Nov          | Total             |
|----------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| no. of droppings examined        | 206               | 152               | 40                | 108               | 506               |
| Unknown                          | 53.9 <sup>a</sup> | 52.0 <sup>a</sup> | 65.0 <sup>a</sup> | 61.1 <sup>a</sup> | 55.7 <sup>a</sup> |
| <i>Neisosperma oppositifolia</i> | 18.4              |                   | 2.5               | 4.6               | 8.5               |
| <i>Cycas circinalis</i>          | 8.7               | 8.6               |                   | 10.2              | 8.3               |
| <i>Pandanus tectorius</i>        | 6.8               | 2.0               |                   | 10.2              | 5.5               |
| <i>Artocarpus</i> sp.            | 2.9               | 10.5              | 7.5               |                   | 4.9               |
| <i>Mammea odorata</i>            | 5.8               |                   |                   | 11.1              | 4.7               |
| <i>Ficus</i> sp.                 | 1.0               | 6.6               | 17.5              |                   | 3.8               |
| <i>Cestrum diurnum</i>           | 2.4               | 7.2               | 2.5               | 1.9               | 3.8               |
| <i>Premna obtusifolia</i>        |                   | 7.2               |                   |                   | 2.2               |
| <i>Pipturus argenteus</i>        |                   | 2.6               |                   | 0.9               | 1.0               |
| <i>Dendrocide latifolia</i>      |                   | 2.0               | 2.5               |                   | 0.8               |
| <i>Passiflora suberosa</i>       |                   | 0.7               |                   |                   | 0.2               |
| <i>Freycinetia reinwardtiana</i> |                   |                   | 2.5               |                   | 0.2               |
| <i>Aglaia mariannensis</i>       |                   |                   |                   | 0.9               | 0.2               |
| Hair                             |                   | 0.7               |                   |                   | 0.2               |

<sup>a</sup> Percent of total droppings

**Table 4.** Number of harem females observed with unweaned young at colonies on Guam and Rota from October 1988 to January 1989.

|             | No. of females observed | No. of females without young | No. of females w/ small young | No. of females w/ medium young | No. of females w/ large young | % of females with young |
|-------------|-------------------------|------------------------------|-------------------------------|--------------------------------|-------------------------------|-------------------------|
| <u>Guam</u> |                         |                              |                               |                                |                               |                         |
| Oct         | 76                      | 67                           | 9                             | 0                              | 0                             | 11.8                    |
| Nov         | 94                      | 80                           | 14                            | 0                              | 0                             | 14.9                    |
| Dec         |                         |                              |                               |                                |                               | No Data                 |
| Jan         | 100                     | 87                           | 13                            | 0                              | 0                             | 13.0                    |
| Total       |                         | 234                          | 36                            | 0                              | 0                             | 13.2*                   |
| <u>Rota</u> |                         |                              |                               |                                |                               |                         |
| Nov         | 35                      | 25                           | 7                             | 3                              | 0                             | 28.6                    |

\* = Monthly average is the sum of the percent of females with young for each month divided by 3.

**Table 5.** Summary of Marianas fruit bat movements between islands in the Marianas from 1978 to 1988.

|     | Date           | Islands            | No. of Bats   | Cause if Known                       |
|-----|----------------|--------------------|---------------|--------------------------------------|
| 1.  | 1979           | Rota to Guam       | 225-250       |                                      |
| 2.  | April-May 1981 | Rota to Guam       | 250           | Hunting                              |
| 3.  | early 1980's   | Rota to Guam       | several       |                                      |
| 4.  | early 1980's   | Rota to Guam       | several       |                                      |
| 5.  | 26-27 Jan 1988 | Rota to Guam       | 300           | Disturbed by biologists during count |
| 6.  | May 1988       | Guam to Rota       | 300           |                                      |
| 7.  | July 1985      | Rota to Aguijan    | 50-75         | Probably hunting                     |
| 8.  | early 1988     | Rota to Aguijan    | 300           | Probably hunting                     |
| 9.  | May 1985       | Anatahan to Saipan | 3             |                                      |
| 10. | July 1985      | Anatahan to Saipan | 5-10          |                                      |
| 11. | Sept 1983      | Guguan to Sarigan  | 2 single bats |                                      |
| 12. | 1960's         | Alamagan to Pagan  | 1             |                                      |



Table 6. Numbers of frozen fruit bats requested for import to Guam between October 1, 1988 to September 30, 1989.

|                  | Oct   | Nov   | Dec    | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Total  | No. of<br>Permits<br>Issued |
|------------------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-----------------------------|
| Palau            | 1,650 | 3,917 | 7,255  | 4,030 | 2,193 | 3,680 | 2,720 | 2,581 | 3,261 | 4,415 | 3,407 | 2,260 | 41,369 | 542                         |
| Pohnpei          | 1,460 | 1,122 | 2,360  | 520   | 1,345 | 990   | 1,615 | 3,620 | 1,930 | 1,085 | 2,420 | 2,110 | 20,577 | 216                         |
| Truk             | 2,584 | 1,335 | 2,256  | 1,400 | 900   | 580   | 476   | 150   | 1,060 | 560   | 325   | 660   | 12,286 | 101                         |
| Philippines      | 100   | 300   | 12     |       |       |       |       |       |       | 250   |       | 50    | 712    | 8                           |
| Yap              |       | 300   | 75     | 100   |       |       |       |       |       |       |       |       | 475    | 4                           |
| Papua New Guinea | 100   | 100   |        |       |       | 50    |       |       |       |       |       | 100   | 350    | 4                           |
| Kosrae           | 50    |       |        |       | 100   |       |       |       |       |       |       | 60    | 310    | 4                           |
| Western Samoa    |       |       |        |       |       |       |       | 50    |       | 180   |       |       | 230    | 3                           |
| Indonesia        |       |       |        |       | 100   |       |       |       |       | 100   |       |       | 100    | 1                           |
| Australia        |       |       |        |       |       |       |       |       |       | 100   |       |       | 100    | 1                           |
| TOTAL            | 5,944 | 7,074 | 11,958 | 6,050 | 4,638 | 5,300 | 4,811 | 6,401 | 6,251 | 6,690 | 6,152 | 5,240 | 76,509 | 884                         |

Table 7. Numbers of frozen fruit bats imported to Guam from October 1, 1988 to September 30, 1989.

|                | Oct   | Nov   | Dec   | Jan   | Feb | Mar   | Apr   | May   | Jun | Jul   | Aug   | Sep | Total* | No. of<br>Shipments<br>Received* | No. of<br>Bats<br>Confiscated | No. of<br>Shipments<br>Confiscated |
|----------------|-------|-------|-------|-------|-----|-------|-------|-------|-----|-------|-------|-----|--------|----------------------------------|-------------------------------|------------------------------------|
| Palau          | 317   | 1,293 | 1,781 | 478   | 324 | 534   | 364   | 686   | 453 | 562   | 513   | 227 | 7,532  | 209                              | 112                           | 19                                 |
| Pohnpei        | 650   | 373   | 1,052 | 138   | 459 | 333   | 597   | 972   | 253 | 881   | 429   | 341 | 6,478  | 84                               | 201                           | 8                                  |
| Truk           | 689   | 245   | 306   | 563   |     | 160   | 99    | 76    | 164 | 4     | 201   |     | 2,507  | 34                               | 48                            | 6                                  |
| Yap            |       | 15    | 22    |       |     |       | 8     | 11    | 6   |       | 3     |     | 65     | 8                                | 28                            | 6                                  |
| American Samoa |       |       |       |       |     |       |       |       |     | 35    |       |     | 35     | 1                                | 35                            | 1                                  |
| Saipan         | 2     | 7     |       |       |     | 3     |       |       | 3   |       |       |     | 15     | 5                                | 15                            | 5                                  |
| Kororae        |       |       |       |       |     |       |       |       |     |       | 15    |     | 15     | 1                                | 0                             | 0                                  |
| Unknown        |       |       |       | 1     |     |       |       | 4     |     |       |       | 12  | 5      | 2                                | 5                             | 2                                  |
| TOTAL          | 1,658 | 1,933 | 3,161 | 1,180 | 783 | 1,030 | 1,068 | 1,749 | 879 | 1,482 | 1,161 | 580 | 16,664 | 345                              | 456                           | 49                                 |

\*Totals include confiscated bats.

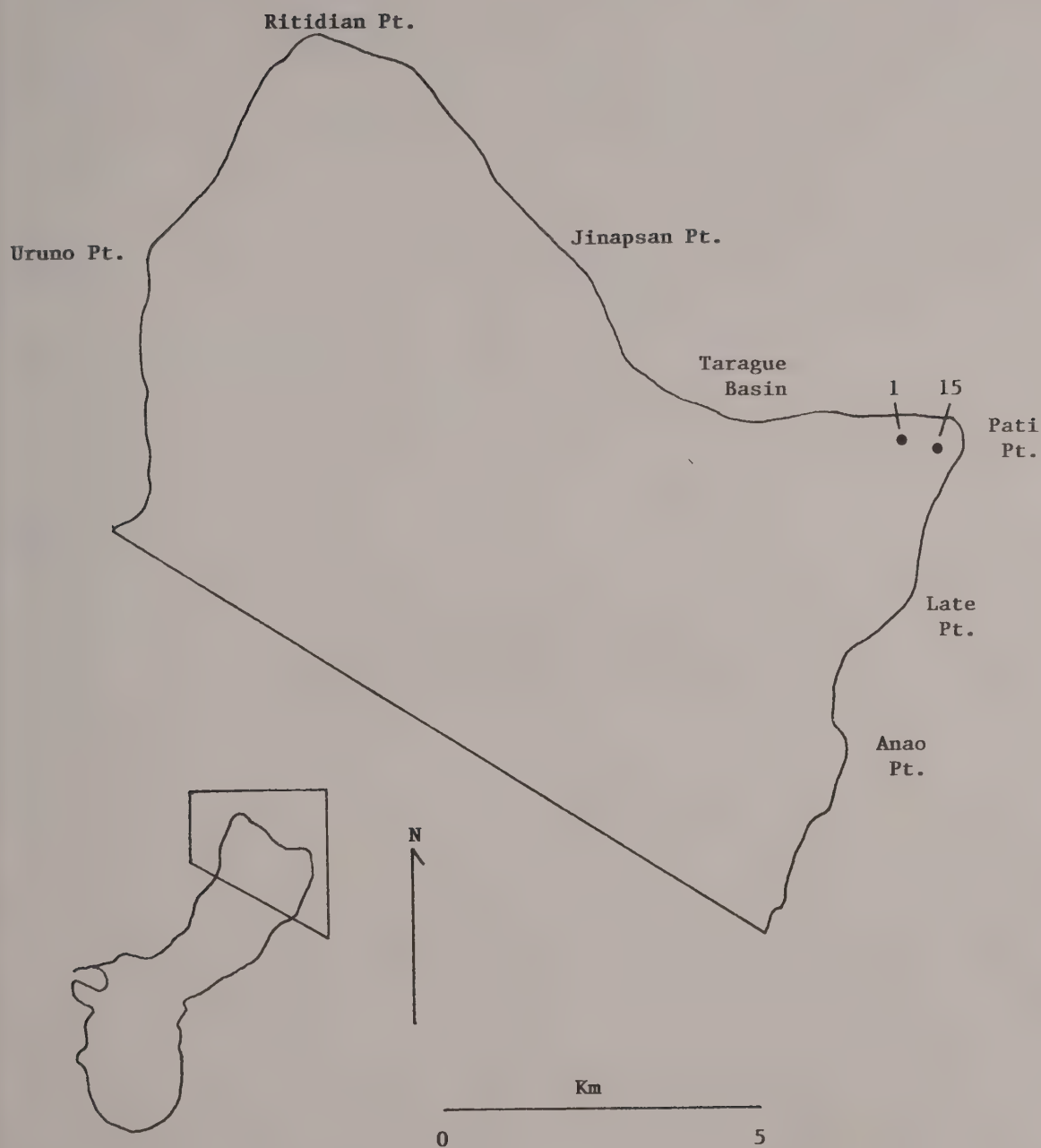


Figure 1. Locations of two roosts used by Marianas fruit bats in northern Guam, FY1989. Numbers correspond to roost numbers listed in Table 1. Roosts are designated by closed circles (●).





**GUAM FISHERIES INVESTIGATIONS  
PROJECTS FW-2R-26  
Federal Aid in Sport Fish Restoration Act**



## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** E

**STUDY NO.:** F-1

**JOB NO.:** 1

**JOB TITLE:** Offshore Fisheries Survey

**PERIOD COVERED:** October 1, 1988 to September 30, 1989.

### **SUMMARY**

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin and other boat launching locations along Guam's shoreline from October 1988 through September 1989. An island-wide finfish catch is estimated at 261.8 metric tons (m.t.) for that period. The bulk of the catch, 202.6 m.t., was landed by trolling during an estimated 48,484 boat-hours of effort. The bulk of the troll catch, 194.9 m.t., consisted of five major pelagic species. Bottomfishing produced an estimated 24.2 m.t., primarily snappers and emperors, and night-light jigging for atulai produced an estimated 24.3 m.t. Spearfishing produced 9.0 m.t. of finfishes and 1.1 m.t. of shellfish. Approximately 0.4 m.t. of finfish and 0.2 m.t. shellfish were caught by hand or gill net. Catches by infrequently encountered methods may be underestimated as follows: night-light jigging for atulai (1.0%); bottomfishing (1.7%); spearfishing (31.0%); and other methods combined (33.6%).

### **BACKGROUND**

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods used and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past twelve years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. Recently, however, major advances have been made in both field survey techniques and in the area of computerized statistical analysis. Much of this progress has resulted from the combined efforts of DAWR and National Marine Fisheries Service (NMFS) personnel through the Western Pacific Fisheries Information Network (WPACFIN) program (see Study F-1, Job 3).

### **OBJECTIVES**

1. To quantify fishing participation, effort, and catch which occurs outside the reef margin in boats.
2. To collect biological data from the specimens examined during interviews.

## PROCEDURES

During FY '89, interviews of returning offshore fishing parties were conducted on four days each month at the Agana Boat Basin. Two of these days were randomly selected weekdays and two were randomly selected weekend days (which, in this report, includes holidays). Each survey consisted of two periods, one from 0500 to 1100 hours and the other from 1600 to 2400 hours. In addition, interviews from the southern launching site of Merizo Pier were obtained on one day per month, alternating between weekdays and weekends from the hours of 0600 to 1100 and 1600 to 2000. Island-wide participation was determined by means of a morning and evening survey of all public boat launching areas in which all trailers attached to vehicles were counted, but no interviews were taken. This assumes that the proportion of boat trips participating in fishing to boat trips not participating in fishing as well as the proportion of boats engaging in each method for boats utilizing the Agana Boat Basin is representative of the island as a whole.

Sampling and analytical procedures used in the GOES (Guam Offshore Expansion System) remain basically unchanged from those outlined in the FY '85 annual report, with the following exceptions:

1. The changes implemented in response to observations of fishing activity during the three-day Guam International Fishing Derby (GIFD) remain the same as those outlined in the FY '88 annual report. Therefore the statistics for the month of August and for the year for trolling and bottomfishing are based on 28-day and 362-day expansions with the GIFD results added for trolling, respectively, and statistics for the remaining methods are based on 31-day and 365-day expansions for August and the year, respectively\*.
2. The method used to assess the degree of undersampling reflected in the GOES output for the FY '85-'88 annual reports assumes that there are no differences between WD and WE/H days, and in the case of spearfishing, assumes that there is no difference between scuba and snorkeling methods. Therefore, this method was modified to consider each of these potential differences separately by multiplying the average daily parameters of catch and effort separately for each method and day type by the correction factor, F where:

$$F = \frac{n(P_o)}{P_i}$$

$n$  = no. of days (WD or WE/H)  
 $P_o$  = the sum of boats known to participate in a given method for all days censused  
 $P_i$  = the sum of boats known to participate in a given method for days in which an interview was obtained

## RESULTS

### Trolling

An estimated 202.6 m.t. of troll-caught fish were landed island-wide during FY '89 (Table 1). Monthly catches ranged from a high of 26.6 m.t. in March to a low of 8.5 m.t. in October (Figure 1). An estimated 48,484 boat-hours were spent trolling with an average catch rate of 4.2 kg/boat-hour. Monthly catch rates Catch Per Unit Effort (CPUE) ranged from 2.9 kg/boat-hour in October to 6.7 kg/boat-hour in April.

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\* Refer to the appendix for a detailed report on the GIFD.



The usual five pelagic species accounted for the bulk of the catch (95.8%; Table 2). Skipjack tuna (*Katsuwonus pelamis*; 25.0%) was the most important species, followed by wahoo (*Acanthocybium solandri*; 22.7%), blue marlin (*Makaira nigricans*; 22.0%), mahimahi (*Coryphaena hippurus*, 17.7%), and yellowfin tuna (*Thunnus albacares*; 8.4%). Scombrids collectively comprised 46.7% of the total trolling catch.

FY '89 was marked by dramatic drops in the catches of three of the five major species, and by slight changes in participation and effort. The trolling catch dropped 41%, from the historic high of 342 m.t. in FY '88 to 203 m.t. in FY '89. Most of this drop was due to a poor mahimahi catch of 36 m.t., less than 25% of the FY '88 historic high of 146 m.t. Significant drops also occurred in the catches of yellowfin tuna (17 m.t.; down 46%) and skipjack tuna (51 m.t.; down 36%). However, the catches of wahoo and blue marlin increased to historic highs of 46 m.t. (up 20%) and 45 m.t. (up 50%), respectively. Among the minor species, the catches of rainbow runner (*Elagatis bipinnulatus*) and sailfish (*Istiophorus platypterus*) were down by 61% and 16%, respectively, while the barracuda (*Sphyrnaea barracuda*) catch was up by 40%.

Participation and effort also declined somewhat from the all-time highs of FY '88. The time spent fishing as measured by person-hours and boat-hours, dropped to 171,680 (down 14%) and 48,484 (down 15%), respectively. The number of boat trips and person-trips decreased even less, to 10,973 (down 5%) and 39,490 (down 6%), respectively. The lesser declines are likely due to the offsetting effects of a continuing increase in charter boat activity, since charter trips are characterized by more participants and shorter hours than non-charter trips. However, all of these declines in measurements of participation and effort are within the 90% confidence limits, and are not considered significant.

## Bottomfishing

An estimated 24.2 m.t. of bottomfishes were landed island-wide during FY '89 (Table 3). Monthly catches ranged from a high of 5.4 m.t. in March to a low of 0.5 m.t. in December. Bottomfish landings fluctuated widely, with generally poorer catches from December to February. An estimated 26,356 person-hours were spent during 10,406 boat-hours of bottomfishing, resulting in an overall catch rate of 2.3 kg/boat-hour. Monthly catch rates ranged from 0.5 kg/boat-hour in May to 3.5 kg/boat-hour in April.

The estimated bottomfishing catch and all measures of effort for FY '89 remain virtually unchanged from those of FY '88, indicating that the dramatic increases in catch and effort for that year have leveled off.

The composition of FY '89 bottomfish catch was also very similar to that of FY '88, with snappers (Lutjanidae) and emperors (Lethrinidae) accounting for 39% and 20% of the weight landed, respectively (Table 4). The most important snappers were the deepwater yellowtail kalikali (*Pristipomiodes auricilla*, 2.2 m.t.); followed by uku (*Aprion virescens*, 1.7 m.t.), a shallow species that ranges into deeper water; the deepwater gindai (*P. zonatus*, 1.3 m.t.); lehi (*Aphareus rutilans*, 1.0 m.t.); onaga (*Etelis coruscans*, 0.6 m.t.); ehu (*E. carbunculus*, 0.6 m.t.); opakapaka (*P. filamentosus*, 0.5 m.t.); yellow-eye opakapaka (*P. flavipinnis*); red snapper (tagafe, *Lutjanus bohar*, 0.4 m.t.), a relatively shallow water species; and funai (*Lutjanus kasmira*, 0.4 m. t.), a shallow water species that ranges into deep water. The emperor catch consisted primarily of the redgilled emperor (*Lethrinus rubrioperculatus*, 3.9 m.t.) which remained the single most important bottomfish species, comprising 16% of the overall bottomfishing catch and 79% of the emperor catch. As in FY '88, groupers (Serranidae; 1.8 m.t.) ranked third in importance (8%) with two species (*Epinephelus fasciatus*, 0.9 m.t. and *Variola louti*, 0.4 m.t.)

predominating. Other important families included the jacks (Carangidae; 7%), requiem sharks (Carcharhinidae; 3%), tunas (Scombridae, entirely *Gymnosarda unicolor*; 3%), unidentified rays (Myliobatiformes; 3%), squirrelfishes (Holocentridae; 1%), and triggerfishes (Balistidae; 1%). Catches of sharks and triggerfishes may be underestimated because they are often considered undesirable and thrown back.

Relatively shallow water species (found primarily at depths of 150 m or less) comprised slightly more than twice as much of the catch (16.1 m.t. or 67%) as did deeper water species (found primarily below 150 m; 8.0 m.t. or 33%). The continued importance of small species with high turnover rates at shallow to moderate depths (e.g. *Lethrinus rubrioperculatus* and *Epinephelus fasciatus*) is indicative of a heavily-fished resource. However, relatively steady CPUEs indicate that the fishery is stable at current levels of participation. Unchecked increases in participation could result in significantly lower CPUEs and catches in the future. Since the GOES does not distinguish between shallow and deep effort, a rough allocation of relative effort will have to be made by checking the species composition of each interview. That will be done at a future date.

### Spearfishing

The estimated monthly and annual participation, effort, and catch for spearfishing from boats during FY '89 is summarized in Tables 5 and 6. (Readers should also refer to Study F-1, Job 2 for estimates of spearing from shore, i.e., without the use of boats, to gain a more complete picture of FY '89 spearfishing activities on Guam.)

An estimated 10.1 m.t. of speared fish, crustaceans, and mollusks were landed from boats during FY '89, 17% less than the historic high catch of 12.2 m.t. in FY '88, even though more people (5% more than in FY '88) spent more time (33% more person-hours than in FY '88) at this activity than ever before. The bulk of effort was by snorkeling rather than scuba diving (1,320 vs 686 boat hours), but only slightly more of the catch was by that method (5.3 m.t. snorkeling vs. 4.6 m.t. using scuba). The average catch rate for spearfishing was approximately 4.8 kg/boat-hour, 17% lower than last year's rate and as much as 24% lower than those of FY '85-'87. Since some spearfishing parties return late at night outside our survey period and the GOES only considers complete interviews, we believe that the above estimates are low. Based on days in which participation in spearfishing occurred, but interviews were not obtained, it is believed that the GOES expansion for FY '89 underestimates the spearfishing catch by at least 31%.

As in previous years, parrotfishes (Scaridae; 39%) clearly dominated the FY '89 spearfishing finfish catch (Table 7). Surgeonfishes (Acanthuridae; 20%) were second in importance, followed by wrasses (Labridae; 11%), rudderfishes (Kyphosidae; 8%), snappers (Lutjanidae; 4%), jacks (Carangidae; 3%), squirrelfishes (Holocentridae; 2%), sweetlips (Haemulidae; 1.4%), groupers (Serranidae; 2%), goatfishes (Mullidae; 1%), emperors (Lethrinidae; 1%), and rabbitfishes (1%).

Other families each comprising less than 1% of the catch included flying fishes (Exocoetidae), cornet fishes (Fistulariidae), fusiliers (Caesionidae), sweepers (Pempheridae), batfishes (Ehippidae), angelfishes (Pomacanthidae), hawkfishes (Cirrhitidae), mullets (Mulgilidae), flounders (Bothidae), triggerfishes (Balistidae), and filefishes (Monacanthidae).

In addition to fishes, an estimated 1.1 m.t. (11% of the catch) of mollusks (primarily octopuses) and crustaceans (primarily spiny lobsters) were harvested by spearfishing parties during FY '89.

## Atulai Night-Light Jigging

Atulai (*Selar crumenophthalmus*) fishing was encountered during all months of the year except December, February, and May.

An estimated 24.0 m.t. of fishes were landed by night-light jigging during 4,126 boat-hours of effort in FY '89. Twenty-one m.t. of the catch (86.4%) consisted of atulai (*Selar crumenophthalmus*); the remaining incidental catch consisted of barracudas (1.7 m.t.; 7.1%), dogtooth tuna (*Gymnosarda unicolor*, 0.8 m.t.; 3.2%), jacks (0.5 m.t.; 1.9%, mostly *Caranx sexfasciatus*), and smaller quantities of snappers, emperors, squirrelfishes, and hawkfishes. This was the largest catch of record, surpassing the 18.5 m.t. of FY '85 by 31% and eight times larger than the 3 m.t. landed the previous year. The large catch resulted from an all-time high in effort combined with a relatively high CPUE of 5.9 kg per boat-hour (exceeded in recent years only by the 7.6 kg/boat-hour of FY '86). For the first time in the survey, interviews were obtained on nearly every day this method was encountered, indicating that the GOES underestimated the catch by only 1%.

## Other Methods

Other rarely encountered methods during FY '88 included gill-netting, cast netting, spin-casting from an anchored boat, and by hand (the latter method may utilize a knife or hand tool or no equipment at all). Together, they produced an estimated catch of 0.6 m.t., (0.4 m.t. of finfishes and 0.2 m.t. of topshell, (*Trochus niloticus*) during 246 boat-hours of effort. It is believed that the GOES underestimated the combined catch of these methods by about 34%.

## Overview

Including the GIFD, an estimated 261.8 m.t. (90% confidence limit [CL]  $\leq$  47.5 m.t.) of finfish (260.5 m.t.) and shellfish (1.3 m.t.) were landed island-wide by boats utilizing a variety of methods beyond the reef margin during FY '89. An estimated 15,223 boat trips (CL  $\leq$  1,347) were made in which 214,603 person-hours (CL  $\leq$  24,453) were spent during 65,400 boat-hours of fishing (CL  $\leq$  7,551). Excluding the GIFD, the average daily participation is estimated at 23.9 boat trips per weekday and 56.1 boat trips per weekend day or holiday, essentially unchanged from FY '88, but 77% and 39% greater than in FY '87, respectively.

Excluding the GIFD, overall monthly catch rates (kg/boat-hour) ranged from 2.9 kg/boat-hour in December to 5.9 kg/boat-hour in April with an annual average of 4.0 kg/boat-hour, 20% lower than that of FY '88. Trolling accounted for 77.4% of the FY '89 catch (202.6 m.t., 90% CL = 38.4 m.t.), bottomfishing comprised 9.3% of the catch (24.2 m.t.; 90% CL = 7.4 m.t.), spearfishing accounted for 3.8% (10.1 m.t.; 90% CL = 5.5 m.t.) of the catch, night-light jigging for atulai accounted for 9.3% of the catch (24.0 m.t.; 90% CL = 11.2 m.t.), and other rare methods accounted for less than 0.03% (0.6 m.t.) of the catch.

The trolling catch declined significantly (41%) from the all time high in FY '88 and CPUE for trolling declined 30% from the high level of FY '88 to the lowest level since FY '79. This was due primarily to a very poor run of mahimahi, and doubtlessly contributed to a slight decline in trolling participation in FY '89.

The FY '89 atulai catch was the largest on record, due to a record level of effort and a relatively high CPUE. This increased effort was probably a result of many fishermen shifting their activity from trolling as well as the relative success of fishing for atulai itself.



The FY '89 bottomfishing catch remained essentially unchanged from the previous year's catch while the spearfishing catch appeared to have decreased somewhat. CPUEs for bottomfishing and spearfishing, which had been declining since FY '85, remained at approximately the same levels for the past three years while participation has leveled off after having doubled between FY '87 and FY '88. Although relatively steady CPUEs indicate that these fisheries are stable at current levels of participation, unchecked increases in participation could result in significantly lower CPUEs and catches in the future. There is little doubt that the high levels of boating and fishing activity of the last two years is the result of Guam's current economic boom and rapid development and that these levels will probably continue to increase as long as the economy is healthy.

## RECOMMENDATIONS

There is little doubt that the reliability of estimates of islandwide catch and effort based on the present survey is limited by the quality of participation data taken at sites other than the Agana Boat Basin under the assumption that activity as well as catches landed there are representative of the island as a whole. However, data collected at Merizo Pier in FY '89 indicates that this is not the case, but that there is proportionately much less trolling activity and much more bottomfishing and spearfishing activity occurring there. We still do not have a clear idea how much boating participation takes place from less accessible landings (e.g. the private Achang Bay Marina), nor do we know the proportionality of the various methods at these areas. Island-wide estimates for the past several years are therefore disproportionately high for trolling, but low for other methods. Since these other methods are the only ones that are locally manageable, it is imperative that the survey results be based on separate expansions for the Agana Boat Basin and other boat launching sites. It will also be necessary to reassess annual island-wide estimates of catch and effort as far back as possible.

Since all major trolling species have broadly distributed stocks, some of which are believed to be Pacific-wide, meaningful management and conservation of these resources will only be possible by international regional cooperation. This will require that data bases be made available from as many sources and areas as possible, and that any biological assessment be based on adequate region-wide data. There are presently few areas from which adequate data on recreational or subsistence fisheries are available, significant gaps in the data for both foreign and domestic distant-water fisheries, and virtually no information on the interaction of recreational and large-scale commercial fisheries. It is therefore essential that the current time-series of data from Guam be maintained. Since Guam's recreational troll fishery is incapable of taking more than a fraction of a percent of these stocks and could not have an adverse affect on them, and since the activities of both domestic and foreign large-scale commercial fisheries can significantly affect the performance of Guam's recreational fishery, it is imperative that Guam's recreational fisheries interests be represented and protected in any regional forum.

Therefore, we recommend that this job continue, that sampling techniques continue to be refined or expanded as necessary, and that historical annual estimates of catch and effort be reassessed. We also recommend that staff fisheries biologists continue to work closely with NMFS personnel in improving the efficiency and accuracy of our computerized data analysis techniques, and that they take an active roll in regional management activities.

Report prepared by: Robert F. Myers



Table 1. Estimated monthly and annual trolling participation, effort, and catch during FY '89. Estimates include the GIFD. Weights are in kilograms (1 kg = 2.2 lbs).

| A) PARTICIPATION: |                     |          |          |                   |         |         |
|-------------------|---------------------|----------|----------|-------------------|---------|---------|
| MONTH             | NO. OF PERSONS      | SE       | 90% CL   | NO. OF BOAT-TRIPS | SE      | 90% CL  |
| OCT               | 2,933.1             | 667.2    | 1,570.0  | 835.9             | 138.3   | 325.5   |
| NOV               | 3,741.0             | 726.4    | 1,709.3  | 1,103.5           | 121.5   | 285.8   |
| DEC               | 2,915.8             | 431.6    | 1,015.6  | 921.6             | 82.1    | 193.2   |
| JAN               | 4,011.6             | 591.0    | 1,390.6  | 1,154.1           | 147.1   | 346.1   |
| FEB               | 3,766.3             | 2,077.5  | 4,888.4  | 787.1             | 437.9   | 1,030.3 |
| MAR               | 4,370.5             | 644.3    | 1,516.0  | 1,324.7           | 166.0   | 390.7   |
| APR               | 1,849.2             | 613.0    | 1,442.5  | 610.6             | 283.2   | 666.4   |
| MAY               | 2,298.1             | 262.7    | 618.1    | 622.6             | 137.2   | 322.9   |
| JUN               | 2,724.7             | 392.8    | 924.3    | 776.6             | 107.9   | 253.8   |
| JUL               | 4,296.1             | 590.4    | 1,389.2  | 1,007.1           | 158.8   | 373.8   |
| AUG               | 2,412.3             | 491.8    | 1,157.2  | 678.5             | 178.1   | 419.1   |
| SEP               | 4,354.1             | 559.8    | 1,317.1  | 1,233.9           | 135.9   | 319.8   |
| TOTAL GOES        | 39,672.8            |          |          | 11,056.2          |         |         |
|                   | 39,490.2            | 2,606.3  | 4,389.0  | 10,973.3          | 663.7   | 1,117.7 |
| B) EFFORT:        |                     |          |          |                   |         |         |
| MONTH             | NO. OF PERSON-HOURS | SE       | 90% CL   | NO. OF BOAT-HOURS | SE      | 90% CL  |
| OCT               | 10,444.5            | 2,569.2  | 6,045.4  | 2,953.2           | 554.4   | 1,304.5 |
| NOV               | 16,687.5            | 2,519.5  | 5,928.5  | 4,984.3           | 440.6   | 1,036.7 |
| DEC               | 14,424.4            | 2,917.1  | 6,864.0  | 4,533.5           | 820.7   | 1,931.1 |
| JAN               | 18,951.4            | 2,857.1  | 6,722.8  | 5,528.5           | 648.9   | 1,526.9 |
| FEB               | 15,575.6            | 9,114.6  | 21,446.6 | 3,378.5           | 2,061.8 | 4,851.4 |
| MAR               | 21,619.5            | 4,127.0  | 9,710.9  | 6,616.7           | 1,197.3 | 2,817.2 |
| APR               | 8,299.8             | 2,784.7  | 6,552.4  | 2,763.5           | 1,289.6 | 3,034.3 |
| MAY               | 9,523.1             | 3,072.5  | 7,229.6  | 2,723.3           | 1,122.8 | 2,641.9 |
| JUN               | 12,592.5            | 2,353.2  | 5,537.0  | 3,569.8           | 659.7   | 1,552.3 |
| JUL               | 15,075.5            | 2,214.0  | 5,209.4  | 3,517.4           | 586.3   | 1,379.6 |
| AUG               | 12,165.8            | 2,081.5  | 4,897.8  | 3,324.7           | 609.1   | 1,433.1 |
| SEP               | 16,762.0            | 2,663.7  | 6,267.7  | 4,748.6           | 787.4   | 1,852.7 |
| TOTAL GOES        | 172,121.6           |          |          | 48,642.0          |         |         |
|                   | 171,680.2           | 12,077.7 | 20,338.9 | 48,484.0          | 3,429.3 | 5,774.9 |
| C) CATCH:         |                     |          |          |                   |         |         |
| MONTH             | NO. OF KILOGRAMS    | SE       | 90% CL   | Kg/B-T            | Kg/B-H  | Kg/P-H  |
| OCT               | 8,530.5             | 2,632.4  | 6,194.0  | 10.2              | 2.9     | 0.8     |
| NOV               | 18,675.2            | 3,636.0  | 8,555.4  | 16.9              | 3.8     | 1.1     |
| DEC               | 13,498.3            | 5,673.9  | 13,350.8 | 14.7              | 3.0     | 0.9     |
| JAN               | 20,253.6            | 7,924.9  | 18,647.2 | 17.6              | 3.7     | 1.1     |
| FEB               | 11,009.9            | 8,720.6  | 20,519.6 | 14.0              | 3.3     | 0.7     |
| MAR               | 26,608.8            | 1,797.8  | 4,230.2  | 20.1              | 4.0     | 1.2     |
| APR               | 18,445.9            | 13,430.9 | 31,602.9 | 30.2              | 6.7     | 2.2     |
| MAY               | 13,521.9            | 5,235.1  | 12,318.2 | 21.7              | 5.0     | 1.4     |
| JUN               | 12,195.5            | 2,962.0  | 6,969.6  | 15.7              | 3.4     | 1.0     |
| JUL               | 18,739.7            | 9,275.6  | 21,825.4 | 18.6              | 5.3     | 1.2     |
| AUG               | 17,668.3            | 6,570.0  | 15,459.2 | 25.6              | 5.2     | 1.4     |
| SEP               | 24,224.8            | 7,136.9  | 16,793.1 | 19.6              | 5.1     | 1.5     |
| TOTAL GOES        | 203,372.4           |          |          | 18.4              | 4.2     | 1.2     |
|                   | 202,654.5           | 22,814.6 | 38,419.8 | 18.5              | 4.2     | 1.2     |

Table 2. Monthly and annual composition of the Guam trolling catch during FY '89. Estimated weights are in kilograms and include the GIFD. A + indicates less than 0.05% of the annual catch.

| Family and Species              | Oct     | Nov      | Dec      | Jan 89   | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Total     | % of total |
|---------------------------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|------------|
| Carcharhinidae                  |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Carcharhinus falciformis</i> | 90.8    |          |          |          |          |          |          |          |          |          |          |          | 90.8      | +          |
| Belonidae                       |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Ablemes hiuns</i>            |         | 23.9     |          |          |          |          |          |          |          |          |          |          | 91.8      | +          |
| <i>Tylosurus crocodilus</i>     |         |          |          |          |          | 67.9     | 25.2     |          |          |          |          |          | 25.2      | +          |
| Serranidae                      |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Cephalopholis uroloeta</i>   |         |          |          |          |          |          |          | 8.7      |          |          |          |          | 8.7       | +          |
| <i>Epinephelus hexagonatus</i>  |         |          |          |          |          |          |          | 1.7      |          |          |          |          | 1.7       | +          |
| <i>E. merri</i>                 |         |          |          |          |          |          |          | 1.2      |          |          |          |          | 1.2       | +          |
| Carangidae                      |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Alectis ciliaris</i>         |         |          |          | 92.0     |          |          |          |          |          |          |          |          | 92.0      | +          |
| <i>Carangoides orthogrammus</i> |         |          |          |          |          |          |          | 21.7     |          |          |          |          | 21.7      | +          |
| <i>Caranx ignobilis</i>         |         |          |          |          |          |          |          | 38.6     |          |          |          |          | 38.6      | +          |
| <i>C. melanopygus</i>           |         |          |          |          |          |          |          | 103.1    |          |          |          |          | 293.9     | 0.1        |
| <i>C. papuensis</i>             |         |          |          |          |          |          |          | 11.8     |          |          |          |          | 43.3      | +          |
| <i>Elaeagns bipinnulatus</i>    | 121.0   | 132.4    | 692.5    | 98.6     | 149.6    | 81.0     | 31.9     |          | 49.2     | 142.4    | 37.8     |          | 1,536.4   | 0.8        |
| Corphaenidae                    |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Corphaena hippurus</i>       | 272.3   | 1,241.6  | 395.7    | 12,533.0 | 5,330.2  | 10,255.0 | 4,862.6  | 527.4    | 94.4     | 161.1    | 136.8    | 179.5    | 35,989.7  | 17.7       |
| Lutjanidae                      |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Apuravus furca</i>           |         |          |          |          |          |          |          | 37.8     | 7.4      |          |          | 4.5      | 49.7      | +          |
| Lehinidae                       |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Leirinus herrik</i>          |         |          |          |          |          |          |          | 6.4      |          |          |          |          | 6.4       | +          |
| Mullidae                        |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Parupeneus bifasciatus</i>   |         |          |          |          |          |          |          | 2.5      |          |          |          |          | 2.5       | +          |
| <i>P. multifasciatus</i>        |         |          |          |          |          |          |          | 2.5      |          |          |          |          | 2.5       | +          |
| Syngnathidae                    |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Sphyrna barracuda</i>        | 108.6   |          | 445.2    | 100.8    | 14.4     | 737.9    | 382.7    | 99.1     | 145.0    | 402.9    | 111.4    | 418.2    | 2,966.2   | 1.5        |
| Scombridae                      |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Acanthocybium solandri</i>   | 3,283.7 | 14,467.0 | 7,030.6  | 3,630.7  | 533.6    | 7,985.4  | 1,628.1  | 1,100.2  | 1,023.7  | 1,614.4  | 1,145.1  | 2,641.7  | 46,084.4  | 22.7       |
| <i>Axius thazard</i>            |         |          |          |          |          |          |          |          |          |          |          |          | 4.3       | +          |
| <i>Euthynnus affinis</i>        | 40.9    | 9.2      | 63.3     | 28.5     |          |          |          |          | 9.2      |          |          |          | 265.6     | 0.1        |
| <i>Grammatocybus bilineatus</i> |         |          |          |          |          |          |          |          | 9.2      |          |          |          | 9.2       | +          |
| <i>Gymnosarda unicolor</i>      | 92.5    | 231.1    |          | 314.4    |          | 216.8    | 99.9     |          | 94.4     |          |          |          | 1,049.1   | 0.5        |
| <i>Katsuwonus pelamis</i>       | 3,687.7 | 1,236.1  | 1,608.7  | 2,359.8  | 4,414.0  | 3,034.8  | 5,913.4  | 5,495.8  | 6,276.6  | 6,116.8  | 5,167.6  | 5,547.2  | 50,858.5  | 25.0       |
| <i>Thunnus albacares</i>        | 192.2   | 1,333.6  | 2,202.2  | 1,095.6  | 136.6    | 2,539.9  | 2,103.2  | 1,587.3  | 1,109.9  | 627.4    | 2,385.2  | 1,855.7  | 17,168.8  | 8.4        |
| Istiophoridae                   |         |          |          |          |          |          |          |          |          |          |          |          |           |            |
| <i>Istiophorus platypterus</i>  |         |          |          |          |          | 416.0    | 285.3    |          | 170.3    |          | 56.4     |          | 928.0     | 0.5        |
| <i>Makaira indica</i>           |         |          |          |          |          |          |          | 915.4    |          |          |          |          | 915.4     | 0.4        |
| <i>M. nigricans</i>             | 640.7   |          | 1,059.9  |          | 431.5    | 1,274.3  | 3,113.6  | 3,560.8  | 3,051.6  | 9,674.6  | 8,628.4  | 13,392.0 | 44,827.0  | 22.0       |
| Total                           | 8,530.5 | 18,675.2 | 13,498.3 | 20,253.6 | 11,009.9 | 26,608.8 | 18,445.9 | 13,521.9 | 12,195.5 | 18,739.7 | 17,668.3 | 24,224.8 | 203,372.4 | 100.0      |

Table 3. Estimated monthly and annual Guam bottomfishing participation, effort, and catch during FY '89.

| A) PARTICIPATION: |                     |         |         |                   |         |        |
|-------------------|---------------------|---------|---------|-------------------|---------|--------|
| MONTH             | NO. OF PERSONS      | SE      | 90% CL  | NO. OF BOAT-TRIPS | SE      | 90% CL |
| OCT               | 667.8               | 126.1   | 296.8   | 253.0             | 62.1    | 146.2  |
| NOV               | 304.9               | 69.3    | 163.1   | 123.0             | 15.9    | 37.5   |
| DEC               | 385.9               | 248.0   | 583.4   | 156.4             | 94.2    | 221.5  |
| JAN               | 633.3               | 218.2   | 513.5   | 163.6             | 50.3    | 118.4  |
| FEB               | 179.3               | 158.2   | 372.1   | 78.5              | 69.2    | 162.8  |
| MAR               | 1,118.5             | 198.4   | 466.8   | 520.2             | 103.7   | 244.0  |
| APR               | 433.7               | 263.0   | 618.8   | 189.9             | 116.7   | 274.6  |
| MAY               | 497.6               | 249.3   | 586.7   | 201.1             | 94.0    | 221.2  |
| JUN               | 599.7               | 76.0    | 178.9   | 219.7             | 42.7    | 100.5  |
| JUL               | 812.7               | 281.0   | 661.2   | 311.5             | 128.2   | 301.6  |
| AUG*              | 291.7               | 181.1   | 426.1   | 89.4              | 47.3    | 111.3  |
| SEP               | 1,015.0             | 215.6   | 507.4   | 364.6             | 42.1    | 99.1   |
| TOTAL GOES        | 6,940.1             |         |         | 2,670.9           |         |        |
|                   | 6,808.6             | 708.9   | 1,193.8 | 2,619.9           | 287.0   | 483.3  |
| B) EFFORT:        |                     |         |         |                   |         |        |
| MONTH             | NO. OF PERSON-HOURS | SE      | 90% CL  | NO. OF BOAT-HOURS | SE      | 90% CL |
| OCT               | 2,607.8             | 445.3   | 1,047.9 | 974.3             | 189.8   | 446.5  |
| NOV               | 1,199.3             | 327.7   | 771.0   | 480.8             | 85.5    | 201.1  |
| DEC               | 768.1               | 459.1   | 1,080.3 | 342.7             | 212.3   | 499.7  |
| JAN               | 1,461.6             | 410.6   | 966.1   | 393.2             | 119.8   | 281.9  |
| FEB               | 678.9               | 598.7   | 1,408.8 | 297.0             | 261.9   | 616.3  |
| MAR               | 4,251.7             | 1,019.4 | 2,398.6 | 2,028.9           | 567.4   | 1335.1 |
| APR               | 1,709.1             | 1,108.6 | 2,608.5 | 742.5             | 484.1   | 1139.1 |
| MAY               | 3,346.5             | 2,352.9 | 5,536.5 | 1,221.6           | 777.2   | 1828.9 |
| JUN               | 2,776.1             | 961.3   | 2,262.1 | 1,049.3           | 429.6   | 1010.7 |
| JUL               | 3,569.8             | 1,334.5 | 3,140.1 | 1,402.6           | 649.8   | 1528.9 |
| AUG*              | 880.3               | 446.8   | 1,051.3 | 292.1             | 121.9   | 286.9  |
| SEP               | 3,688.5             | 873.7   | 2,055.8 | 1,415.8           | 274.5   | 645.9  |
| TOTAL GOES        | 26,937.7            |         |         | 10,640.8          |         |        |
|                   | 26,356.1            | 3,510.6 | 5,911.8 | 10,406.4          | 1,416.8 | 2385.9 |
| C) CATCH:         |                     |         |         |                   |         |        |
| MONTH             | NO. OF KILOGRAMS    | SE      | 90% CL  | Kg/B-T            | Kg/B-H  | Kg/P-H |
| OCT               | 2,806.2             | 688.6   | 1,620.3 | 11.1              | 2.9     | 1.1    |
| NOV               | 1,194.3             | 117.6   | 276.7   | 9.7               | 2.5     | 1.0    |
| DEC               | 526.4               | 340.6   | 801.4   | 3.4               | 1.5     | 0.7    |
| JAN               | 593.1               | 150.3   | 353.8   | 3.6               | 1.5     | 0.4    |
| FEB               | 951.0               | 838.7   | 1,973.5 | 12.1              | 3.2     | 0.4    |
| MAR               | 5,386.9             | 1,318.7 | 3,103.0 | 10.4              | 2.7     | 1.3    |
| APR               | 2,624.4             | 2,122.8 | 4,995.1 | 13.8              | 3.5     | 1.5    |
| MAY               | 625.8               | 290.6   | 683.8   | 3.1               | 0.5     | 0.2    |
| JUN               | 1,425.0             | 347.4   | 817.5   | 6.5               | 1.4     | 0.5    |
| JUL               | 3,722.3             | 2,814.8 | 6,623.2 | 12.0              | 2.7     | 1.0    |
| AUG*              | 575.6               | 298.8   | 703.0   | 6.4               | 2.0     | 0.7    |
| SEP               | 4,545.4             | 409.3   | 963.1   | 12.5              | 3.2     | 1.2    |
| TOTAL GOES        | 24,976.4            |         |         | 9.4               | 2.4     | 0.9    |
|                   | 24,233.1            | 4,391.4 | 7,395.1 | 9.3               | 2.3     | 0.9    |

\* Results are based on a 28 day expansion on the assumption that bottomfishing was negligible during the three day GIFD.

\*\*Results are based on a 362 day expansion based on the assumption that bottomfishing was negligible during the three day GIFD.

Table 4. Composition of the Guam bottomfishing catch during FY '89. Estimated weights are in kilograms. Percentages are based on the differentiated portion of the catch only. The data is based on a 362 day expansion which assumes that bottomfishing activity was negligible during the three day GIFD.

| FAMILY                          | Shallow Species<br>(≤150m) |       | Deep Species<br>(>150m) |       | All Species |       |
|---------------------------------|----------------------------|-------|-------------------------|-------|-------------|-------|
|                                 | Weight                     | %     | Weight                  | %     | Weight      | %     |
| Carcharhinidae (Requiem sharks) | 816.1                      | 5.1   |                         |       | 816.1       | 3.4   |
| Myliobatiformes (Rays)          | 636.8                      | 3.9   |                         |       | 636.8       | 2.6   |
| Anguilliformes (Eels)           |                            |       | 206.3                   | 2.6   | 206.3       | 0.9   |
| Holocentridae (Squirrelfishes)  | 292.6                      | 1.8   |                         |       | 292.6       | 1.2   |
| Serranidae (Groupers)           | 1,760.0                    | 10.9  | 73.9                    | 0.9   | 1,833.9     | 7.6   |
| Carangidae (Jack)               | 977.3                      | 6.1   | 692.1                   | 8.7   | 1,669.4     | 6.9   |
| Bramidae (Pomfrets)             |                            |       | 171.8                   | 2.2   | 171.8       | 0.7   |
| Lutjanidae (Snappers)           | 2,900.3                    | 18.0  | 6,650.0                 | 83.5  | 9,550.3     | 39.4  |
| Lethrinidae (Emperors)          | 4,888.2                    | 30.3  |                         |       | 4,888.2     | 20.2  |
| Mullidae (Goatfishes)           | 182.7                      | 1.1   | 27.1                    | 0.3   | 209.8       | 0.9   |
| Sphyraenidae (Barracudas)       | 409.4                      | 2.5   |                         |       | 409.4       | 1.7   |
| Labridae (Wrasses)              | 132.3                      | 0.8   | 14.3                    | 0.2   | 146.6       | 0.6   |
| Acanthuridae (Unicornfishes)    | 128.8                      | 0.8   |                         |       | 128.8       | 0.5   |
| Scombridae (Tunas)              | 808.0                      | 5.0   |                         |       | 808.0       | 3.3   |
| Balistidae (Triggerfishes)      | 282.7                      | 1.8   |                         |       | 282.7       | 1.2   |
| Others*                         | 69.2                       | 0.4   | 69.5                    | 0.9   | 138.7       | 0.6   |
| SUBTOTAL                        | 14,284.4                   | 88.4  | 7,905.0                 | 99.3  | 22,189.4    | 91.6  |
| Undifferentiated**              | 1,853.7                    | 11.5  | 57.3                    | 0.7   | 2,029.4     | 8.4   |
| TOTAL FINFISHES**               | 16,138.1                   | 99.9  | 7,962.3                 | 100.0 | 24,218.8    | 99.9  |
| Octopus                         | 14.7                       | 0.1   |                         |       | 14.7        | 0.1   |
| TOTAL **                        | 16,152.8                   | 100.0 | 7,962.3                 | 100.0 | 24,233.5    | 100.0 |

\* Includes the following families, each comprising less than 100 kg of the catch: Synodontidae, Polymixiidae, Fistulariidae, Scorpaenidae, Priacanthidae, Malacanthidae, Pentapodidae, Pempheridae, and Triodontidae.

\*\*118.4 kg unassignable to species or depth group.



Table 5. Estimated monthly and annual offshore spearfishing (with and without scuba) participation, effort, and catch during FY '89.

| MONTH | PARTICIPATION  |                   | EFFORT            |                 | CATCH            |               |              |             |
|-------|----------------|-------------------|-------------------|-----------------|------------------|---------------|--------------|-------------|
|       | no. of Persons | no. of Boat trips | no. of Person-hrs | no. of Boat-hrs | no. of Kilograms | Kg/ boat trip | Kg/ pers.-hr | Kg/ boat-hr |
| OCT   | 19.0           | 19.0              | 56.9              | 56.9            | 301.6            | 15.9          | 5.3          | 5.3         |
| NOV   | 106.8          | 54.6              | 222.4             | 117.9           | 575.4            | 10.5          | 2.6          | 4.9         |
| DEC   | no. sample     |                   |                   |                 |                  |               |              |             |
| JAN   | no. sample     |                   |                   |                 |                  |               |              |             |
| FEB   | 313.3          | 69.6              | 1,088.0           | 235.0           | 943.7            | 13.6          | 0.9          | 4.0         |
| MAR   | 291.4          | 89.9              | 668.9             | 200.0           | 265.8            | 3.0           | 0.4          | 1.3         |
| APR   | 50.0           | 8.3               | 100.0             | 16.7            | 168.8            | 20.3          | 1.7          | 10.1        |
| MAY   | 189.3          | 75.8              | 430.2             | 181.3           | 794.0            | 10.5          | 1.9          | 4.4         |
| JUN   | 191.4          | 54.5              | 929.9             | 276.4           | 1,327.7          | 24.4          | 1.4          | 4.8         |
| JUL   | 243.5          | 54.8              | 563.6             | 132.6           | 738.4            | 13.5          | 1.3          | 5.6         |
| AUG*  | 180.8          | 77.6              | 664.7             | 287.0           | 2,711.4          | 35.0          | 4.1          | 9.5         |
| SEP   | 727.3          | 233.1             | 1,794.8           | 528.2           | 2,078.9          | 8.9           | 1.2          | 3.9         |
| TOTAL | 2,312.8        | 737.2             | 6,519.4           | 2,032.0         | 9,905.7          | 13.4          | 1.5          | 4.9         |
| GOES  | 2,340.0        | 745.3             | 6,811.9           | 2,100.0         | 10,053.2         | 13.5          | 1.5          | 4.8         |

\* Results are based on a 31 day expansion supported by observations indicating that bottomfishing was unaffected by the three day GIFD.

\*\* Results are based on a 365 day expansion supported by observations indicating that bottomfishing was unaffected by the three day GIFD.

Table 6. Estimated annual Guam offshore spearfishing participation, effort, and catch by method during FY '89.

|                    |  |                  |         |         |                   |               |             |
|--------------------|--|------------------|---------|---------|-------------------|---------------|-------------|
| A) PARTICIPATION:  |  | No. of Persons   | SE      | 90% CL  | No. of Boat trips | SE            | 90% CL      |
| Snorkel            |  | 1,387.9          | 475.3   | 800.3   | 437.9             | 128.8         | 217.0       |
| Scuba              |  | 903.6            | 267.7   | 450.7   | 291.2             | 74.5          | 125.4       |
| Mixed              |  | 48.5             | 30.7    | 51.7    | 16.2              | 10.2          | 17.2        |
| Total Spearfishing |  | 2,340.0          | 773.7   | 1,302.7 | 745.3             | 213.5         | 359.6       |
| B) EFFORT:         |  | Person-hours     | SE      | 90% CL  | Boat-hours        | SE            | 90% CL      |
| Snorkel            |  | 4,330.2          | 1,475.2 | 2,484.2 | 1,320.5           | 383.4         | 645.7       |
| Scuba              |  | 2,202.4          | 773.4   | 1,302.5 | 686.4             | 220.2         | 370.7       |
| Mixed              |  | 279.3            | 185.2   | 311.9   | 93.1              | 61.7          | 104.0       |
| Total Spearfishing |  | 6,811.9          | 2,433.8 | 4,098.6 | 2,100.0           | 665.3         | 1,120.4     |
| C) CATCH:          |  | No. of Kilograms | SE      | 90% CL  | Kg/ boat trip     | Kg/ pers.-hr. | Kg/ boat-hr |
| Snorkel            |  | 5,317.8          | 1,765.2 | 2,972.6 | 12.1              | 1.2           | 4.0         |
| Scuba              |  | 4,566.4          | 1,410.2 | 2,374.8 | 15.7              | 2.1           | 6.7         |
| Mixed              |  | 169.0            | 107.1   | 180.4   | 10.4              | 0.6           | 1.8         |
| Total Spearfishing |  | 10,053.2         | 3,282.5 | 5,527.8 | 13.5              | 1.5           | 4.8         |

Table 7. Composition of the Guam spearfishing catch during FY '89. Percentages of finfishes are of the differentiated portion of the catch only.

| FAMILY                         | SNORKEL |       | SCUBA   |       | MIXED |       | TOTAL    |       |
|--------------------------------|---------|-------|---------|-------|-------|-------|----------|-------|
|                                | Kg.     | %     | Kg.     | %     | Kg.   | %     | Kg.      | %     |
| <u>FISHES</u>                  |         |       |         |       |       |       |          |       |
| Holocentridae (Squirrelfishes) | 143.5   | 3.1   | 43.5    | 1.2   | 5.7   | 4.2   | 192.7    | 2.3   |
| Serranidae (Groupers)          | 91.2    | 2.0   | 59.7    | 1.7   | 21.1  | 15.4  | 172.0    | 2.0   |
| Carangidae (Jacks)             | 187.2   | 4.0   | 63.5    | 1.8   |       | 0.0   | 250.7    | 2.9   |
| Lutjanidae (Snappers)          | 276.2   | 5.9   | 80.7    | 2.3   |       | 0.0   | 356.9    | 4.2   |
| Haemulidae (Sweetlips)         | 107.6   | 2.3   | 83.3    | 2.3   |       | 0.0   | 190.9    | 2.2   |
| Lethrinidae (Emperors)         | 94.9    | 2.0   | 8.3     | 0.2   |       | 0.0   | 103.2    | 1.2   |
| Mullidae (Goatfishes)          | 46.3    | 1.0   | 87.0    | 2.4   |       | 0.0   | 133.3    | 1.6   |
| Kyphosidae (Rudderfishes)      | 656.1   | 14.1  | 9.2     | 0.3   |       | 0.0   | 665.3    | 7.8   |
| Labridae (Wrasses)             | 305.3   | 6.6   | 578.6   | 16.2  | 62.1  | 45.4  | 946.0    | 11.1  |
| Scaridae (Parrotfishes)        | 1,548.2 | 33.3  | 1,742.5 | 48.8  |       | 0.0   | 3,290.7  | 38.6  |
| Acanthuridae (Surgeonfishes)   | 1,052.4 | 22.7  | 661.3   | 18.5  | 17.9  | 13.1  | 1,731.6  | 20.3  |
| Siganidae (Rabbitfishes)       | 44.7    | 1.0   | 41.1    | 1.2   |       | 0.0   | 85.8     | 1.0   |
| Others*                        | 90.7    | 2.0   | 111.8   | 3.1   | 30.0  | 21.9  | 232.5    | 2.7   |
| Differentiated Fishes Subtotal | 4,644.3 | 87.3  | 3,570.5 | 78.2  | 136.8 | 80.9  | 8,351.6  | 83.1  |
| Undifferentiated Fishes        | 329.8   | 6.2   | 276.0   | 6.0   |       | 0.0   | 605.8    | 6.0   |
| Fishes Subtotal                | 4,974.1 | 93.5  | 3,846.5 | 84.2  | 136.8 | 80.9  | 8,957.4  | 89.1  |
| <u>INVERTEBRATES</u>           |         |       |         |       |       |       |          |       |
| Gastropods                     | 14.8    | 0.3   | 197.2   | 4.3   |       | 0.0   | 212.0    | 2.1   |
| Octopuses & Squids             | 182.6   | 3.4   | 58.7    | 1.3   |       | 0.0   | 241.3    | 2.4   |
| Crabs                          | 13.0    | 0.2   | 7.1     | 0.2   | 9.1   | 5.4   | 29.2     | 0.3   |
| Spiny Lobsters                 | 132.8   | 2.5   | 446.2   | 9.8   | 23.3  | 13.8  | 602.3    | 6.0   |
| Slipper Lobsters               |         | 0.0   | 11.8    | 0.3   |       | 0.0   | 11.8     | 0.1   |
| Invertebrate Subtotal          | 343.2   | 6.5   | 721.0   | 15.8  | 32.4  | 19.1  | 1,096.6  | 10.9  |
| TOTAL (All Species)            | 5,317.3 | 100.0 | 4,567.5 | 100.0 | 169.2 | 100.0 | 10,054.0 | 100.0 |

\* Includes the following families, each of which contributed to less than 1% of the overall catch: Exocoetidae (Flyingfishes), Fistulariidae (Cornetfishes), Caesionidae (Fusiliers), Pempheridae (Sweepers), Ehippidae (Batfishes), Pomacanthidae (Angelfishes), Cirrhitidae (Hawkfishes), Mugilidae (Mulletts), Bothidae (Flounders), Balistidae (Triggerfishes), and Monacanthidae (Filefishes).

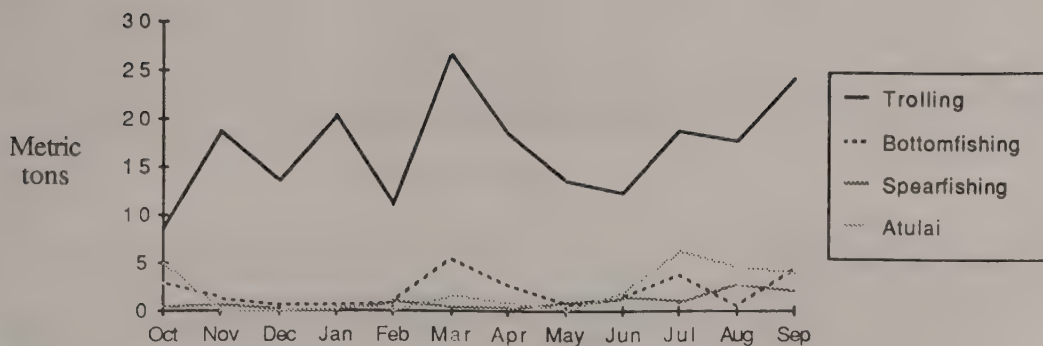
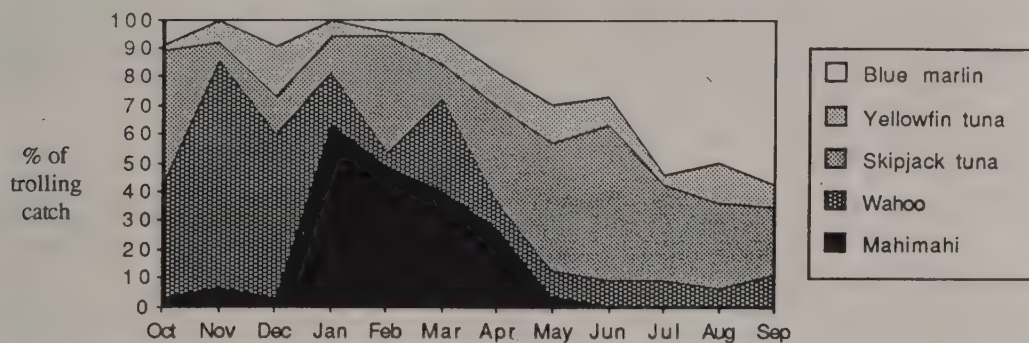
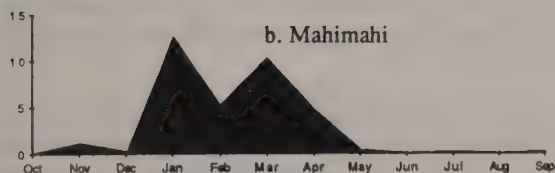


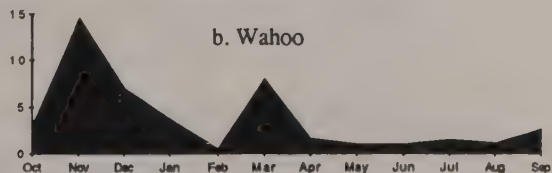
Figure 1. Estimated monthly landings for Guam small-boat offshore fisheries during FY 89.



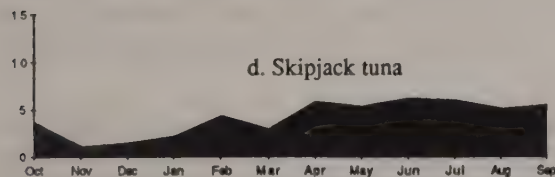
a. Catch composition by weight



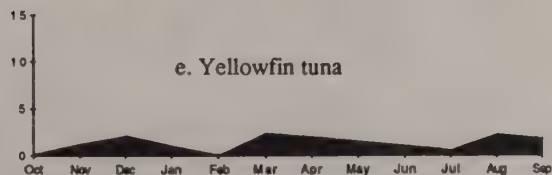
b. Mahimahi



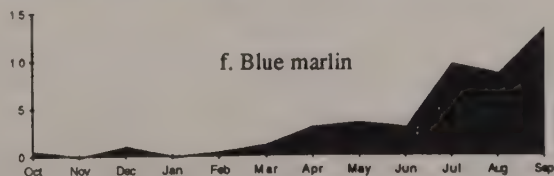
c. Wahoo



d. Skipjack tuna



e. Yellowfin tuna



f. Blue marlin

Figure 2. Estimated monthly landings for Guam's major trolling species during FY 89. All figures except 2a are in metric tons.

## APPENDIX

### Guam International Fishing Derby

August 18-20, 1989

#### INTRODUCTION

The thirteenth Guam International Fishing Derby (GIFD), sponsored by the Guam Fishermen's Cooperative and Guam Visitors Bureau (GVB), was held on Aug, 18, 19, and 20, 1989. Awards were presented to the anglers who landed the first, second, and third heaviest fishes of the following species: blue marlin (*Makaira nigricans*), yellowfin tuna (*Thunnus albacares*), wahoo (*Acanthocybium solandri*) and mahimahi (*Coryphaena hippurus*). As in the past derbies, awards were also given for the greatest three-day total number of fish caught in the above categories combined, as well as for the largest fish caught in a ladies category, and in a children under age 16 category. Records were also kept in an "other species" category by the Division.

#### PROCEDURES

In theory, the determination of GIFD statistics is based on complete catch reports from all participating boats and requires no expansion; but in practice, there is always a significant number of boats that do not provide catch information. Since the Guam Offshore Expansion System (GOES) Tournament Module requires a complete data set, it has not been used, and the estimated derby parameters were added to the GOES monthly and annual output by hand.

Division biologists were present at the single onshore check-out/check-in station at the Agana Boat Basin. Merizo Pier was not included in the GIFD due to logistic constraints and safety considerations. A log of all departing and returning boats was kept and as many returning boats as possible were intercepted for interviews.

Parameters of participation and effort were determined by using daily averages in place of missing data wherever possible. This was done for number of fishermen, number of lines fished, and "down time" when determining hours spent fishing. For these parameters, daily data was missing for approximately 5 to 45% of returning boats, depending on the parameter and day. The number of boat trips and boat hours was known since a log of all departing and returning boats was kept.

Determination of catches required a subjective appraisal of what species were likely to be present in non-intercepted boats. Average daily catch rates by species were assigned to non-intercepted boats in order to determine daily totals. Catches of non-intercepted boats were assumed to contain only non-derby species.

#### RESULTS

##### Participation

Sixty-two boats made 184 fishing trips during the course of the derby, a 30% decrease from the number of trips made during last year's derby. There was an average of 3.4 anglers pulling an average of 3.8 lines per trip. The mean time spent on the water was 8.6



hours per boat trip, of which 8.2 hours were spent fishing. These figures are essentially unchanged from those of last year.

### **Catch**

A record 6,273.8 kg of derby species were landed during the 1989 GIFD (Tables 2, 3). This is 19% higher than the previous record of 5,260.0 kg caught during the 1988 GIFD. The vast bulk of this consisted of blue marlin (5,263.6 kg). Including the by-catch, which accounted for 59% of the fishes but only 21% of the weight, 562 fish weighing 7,969.8 kg were caught. This is slightly lower than the record 8,188.4 kg caught last year. Proportionately more by-catch was caught during the 1988 GIFD than the 1987 derby.

The mean catch per boat per trip was 43.3 kg. Like the overall catch rate, the catch rates for each of the derby species except yellowfin tuna were considerably higher than those of last year's derby (Table 3). The catch rate for blue marlin greatly exceeded those for all other species (3.31 vs <.02 to .37 kg/boat-hour fished).

A record 86 blue marlin weighing 5,263.6 kg were landed during the 1989 GIFD. This is an increase of 48% in number and 31% in weight over all previous derbies. The average weight was a relatively small 61.2 kg and the winning marlin of 182.2 kg has been exceeded during five of the 12 other derbies.

The catch of 81 yellowfin tuna weighing 385.2 kg was the smallest since 1980 and the average size and winning fish were the smallest in the 13 year history of the derby.

The catch of 59 wahoo weighing 588.1 kg was fairly typical of recent derbies. The winning wahoo of 17.9 kg has been exceeded on all but three of the 12 other derbies.

The poor mahimahi catch of 7 fish weighing 36.9 kg was typical of the summer season. However the 18.4 kg winning fish set a new derby record.

At least three "non-derby" species were landed, accounting for the bulk of the individual fishes (59%) and 21% (1,696.0 kg) of the overall derby catch. Nearly all of this consisted of skipjack tuna (1,637.1 kg) with the remainder consisting of 44.7 kg of barracuda and 14.2 kg of rainbow runner.

### **Fishing areas**

Useable locality data was obtained from 70% of the returning boats. This made it possible to compare catches and catch rates by area (Table 4). Most of the fishing effort was spent north of Orote Point (all or part of 95% of the boat trips vs 17% south of Orote). Most of the catch was also from the north, but catch rates were highest at the southern banks for all derby species except mahimahi. Nearly one marlin and one wahoo, and 2.5 yellowfin tuna were caught per boat trip to the southern banks. The largest of the five mahimahi was caught off the southwest coast, and the remaining four were caught to the north. For marlin, the second best area was the northwest coast which was fished on 94% of the boat trips and produced 0.4 marlin per trip. The northern banks had the second highest catch rates for yellowfin tuna and wahoo. This pattern of highest effort and highest catches in the north, but highest catch rates in the south has continued through the last four GIFDs.

## ACKNOWLEDGEMENTS

The fisheries biologists from the Division of Aquatic & Wildlife Resources (DAWR) wish to thank the Guam Fishermen's Cooperative, as well as the competing anglers for their cooperation and assistance in providing the catch information that made this report possible. This cooperation not only makes our job easier and more enjoyable, but insures a more accurate collection of data and better information for the fisherman.

Report prepared by: Robert F. Myers

Table 1. Daily participation, effort and catch in the thirteenth annual Guam International Fishing Derby. Weights are expressed in kilograms (1 kg=2.2 lbs).

|                                  | DAY 1<br>AUG 18 | DAY 2<br>AUG 19 | DAY 3<br>AUG 20 | DERBY<br>TOTALS |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|
| Number of boats                  | 48              | 57              | 50              | 62              |
| Number of boat trips             | 59              | 66              | 59              | 184             |
| Number of fishermen*             | 164             | 169             | 188             | 620             |
| Average number of men per boat   | 3.4             | 3.0             | 3.8             | 3.4             |
| Number of lines fished**         | 212             | 206             | 275             | 693             |
| Average number of lines per boat | 4.4             | 3.6             | 5.5             | 3.8             |
| Boat hours                       | 540.1           | 531.0           | 520.0           | 1,591.1         |
| Fished hours                     | 483.7           | 521.0           | 499.4           | 1,504.1         |
| Average boat trip length         | 9.2             | 8.1             | 8.8             | 8.6             |
| Average time spent fishing       | 8.2             | 7.8             | 8.5             | 8.2             |
| Fisherman hours                  | 1,847.1         | 1,577.0         | 1,957.1         | 5,332.0         |
| Line hours†                      | 2,138.0         | 1,880.8         | 2,746.7         | 5,682.6         |
| Number of fish landed            | 257             | 171             | 143             | 571             |
| Catch landed (lbs)††             | 3,451.0         | 2,189.7         | 2,302.9         | 7,943.6         |
| lbs/boat day                     | 71.90           | 38.42           | 46.06           | 52.13           |
| lbs/boat hour                    | 6.39            | 4.12            | 4.43            | 4.99            |
| lbs/man hour                     | 1.87            | 1.39            | 1.18            | 1.49            |
| lbs/line hour                    | 1.61            | 1.16            | 0.84            | 1.40            |

\* Daily total assumes no turnover of participants for boats with multiple trips per day; derby total is given as 100% turnover.

\*\*Artificial data based on the average number of lines per boat interviewed multiplied by the number of boats.

† Based on actual time spent fishing and overall average number of lines per boat.

†† Includes incidental catch.

Table 2. Daily catch composition for the thirteenth annual Guam International Fishing Derby. Weights are expressed in kilograms (1 kg=2.2 lbs).

|                | DAY 1 - AUG 18   |              |            | DAY 2 - AUG 19   |              |            | DAY 3 - AUG 20   |              |            | DERBY TOTALS     |              |            |
|----------------|------------------|--------------|------------|------------------|--------------|------------|------------------|--------------|------------|------------------|--------------|------------|
|                | NUMBER<br>CAUGHT | TOTAL<br>WT. | AVE<br>WT. | NUMBER<br>CAUGHT | TOTAL<br>WT. | AVE<br>WT. | NUMBER<br>CAUGHT | TOTAL<br>WT. | AVE<br>WT. | NUMBER<br>CAUGHT | TOTAL<br>WT. | AVE<br>WT. |
| Blue marlin    | 38               | 2,115.1      | 55.66      | 22               | 1,413.2      | 64.23      | 24               | 1,679.0      | 69.96      | 84               | 5,207.3      | 61.99      |
| Sailfish       |                  |              |            | 1                | 26.2         | 26.21      | 1                | 30.2         | 30.16      | 2                | 56.4         | 28.19      |
| Yellowfin tuna | 36               | 163.7        | 4.55       | 23               | 109.1        | 4.74       | 22               | 86.2         | 3.92       | 81               | 359.0        | 4.43       |
| Wahoo          | 21               | 201.5        | 9.60       | 25               | 256.7        | 10.27      | 13               | 129.8        | 9.99       | 59               | 588.1        | 9.97       |
| Mahimahi       | 1                | 2.2          | 2.18       | 5                | 25.9         | 5.17       | 1                | 8.8          | 8.84       | 7                | 36.9         | 5.27       |
| Skipjack tuna  | 159              | 959.9        | 6.04       | 88               | 336.7        | 3.81       | 68               | 340.5        | 5.01       | 315              | 1,637.1      | 5.19       |
| Rainbow runner |                  |              |            | 4                | 5.9          | 1.47       | 6                | 8.8          | 1.47       | 10               | 14.7         | 1.47       |
| Barracuda      | 2                | 8.6          | 4.29       | 4                | 16.1         | 4.01       | 8                | 19.6         | 2.45       | 14               | 44.2         | 3.16       |
| TOTALS         | 257              | 3,451.0      | 13.43      | 171              | 2,189.7      | 12.81      | 134              | 2,302.9      | 17.19      | 562              | 7,943.6      | 14.13      |

|                       | 1977            | 1978  | 1979    | 1980    | 1981    | 1982    | 1983    | 1984 <sup>2</sup> | 1985    | 1986    | 1987 <sup>3</sup> | 1988    | 1989                 |
|-----------------------|-----------------|-------|---------|---------|---------|---------|---------|-------------------|---------|---------|-------------------|---------|----------------------|
| <b>BLUE MARLIN</b>    |                 |       |         |         |         |         |         |                   |         |         |                   |         |                      |
| no. caught            | 9               | 9     | 6       | 12      | 34      | 12      | 13      | 47                | 17      | 47      | 44                | 58      | 86                   |
| total weight          | 932.9           | 511.1 | 702.9   | 727.0   | 2,005.0 | 852.2   | 964.2   | 2,840.4           | 1,659.0 | 2,859.0 | 4,063.3           | 3,831.9 | 5,263.6 <sup>3</sup> |
| ave. weight           | 103.6           | 56.8  | 117.2   | 60.6    | 59.0    | 71.0    | 74.2    | 60.4              | 97.6    | 60.8    | 93.2              | 66.1    | 61.2                 |
| winning fish          | 191.8           | 75.3  | 237.2   | 138.8   | 145.1   | 132.0   | 199.1   | 215.4             | 177.8   | 173.7   | 188.2             | 155.3   | 182.2                |
| <b>YELLOWFIN TUNA</b> |                 |       |         |         |         |         |         |                   |         |         |                   |         |                      |
| no. caught            | 18 <sup>5</sup> | 11    | 34      | 50      | 109     | 205     | 100     | 59                | 137     | 71      | 115               | 161     | 81                   |
| total weight          | 239.9           | 254.9 | 637.2   | 307.9   | 1,156.0 | 2,376.9 | 1,105.7 | 388.8             | 1,058.0 | 405.9   | 798.4             | 848.5   | 385.2                |
| ave. weight           | 13.3            | 23.2  | 18.7    | 6.2     | 10.6    | 11.6    | 11.1    | 6.6               | 7.7     | 5.7     | 6.9               | 5.3     | 4.8                  |
| winning fish          | 46.3            | 56.7  | 67.6    | 51.2    | 47.6    | 61.2    | 55.8    | 51.7              | 45.8    | 45.8    | 26.8              | 44.9    | 21.5                 |
| <b>WAHOO</b>          |                 |       |         |         |         |         |         |                   |         |         |                   |         |                      |
| no. caught            | 7               | 9     | 11      | 12      | 33      | 60      | 36      | 46                | 98      | 16      | 31                | 72      | 59                   |
| total weight          | 90.7            | 102.0 | 116.1   | 161.0   | 542.9   | 263.9   | 359.6   | 466.2             | 921.5   | 136.5   | 314.3             | 567.4   | 588.1                |
| ave. weight           | 13.0            | 11.4  | 10.5    | 13.4    | 16.5    | 4.4     | 10.0    | 10.1              | 9.4     | 8.5     | 10.1              | 7.8     | 10.0                 |
| winning fish          | 22.2            | 19.0  | 19.5    | 23.6    | 16.8    | 22.7    | 24.5    | 21.3              | 23.6    | 17.7    | 16.8              | 22.4    | 17.9                 |
| <b>MAHIMAH</b>        |                 |       |         |         |         |         |         |                   |         |         |                   |         |                      |
| no. caught            | 2               | 4     | 5       | 3       | 1       | 14      | 33      | 0                 | 14      | 7       | 3                 | 5       | 7                    |
| total weight          | 13.6            | 26.3  | 52.6    | 39.5    | 0.9     | 63.5    | 195.0   | 0.0               | 76.6    | 61.7    | 39.9              | 12.2    | 36.9                 |
| ave. weight           | 6.8             | 6.6   | 10.5    | 13.1    | 0.8     | 4.6     | 5.9     | 0.0               | 5.5     | 8.8     | 13.4              | 2.4     | 5.3                  |
| winning fish          | 9.1             | 9.1   | 15.0    | 15.9    | 0.9     | 15.0    | 10.9    | 0.0               | 15.0    | 14.5    | 15.4              | 4.3     | 18.4                 |
| <b>DERBY SPECIES</b>  |                 |       |         |         |         |         |         |                   |         |         |                   |         |                      |
| no. caught            | 36              | 33    | 56      | 77      | 177     | 291     | 182     | 152               | 266     | 141     | 193               | 296     | 233                  |
| total weight          | 1,277.6         | 894.3 | 1,508.4 | 1,235.4 | 3,704.8 | 3,556.9 | 2,624.5 | 3,695.2           | 2,716.1 | 3,463.5 | 5,220.9           | 5,260.0 | 6,273.8              |
| most per boat         |                 |       |         |         |         |         |         |                   |         |         | 57                | 42      | 26                   |
| <b>TOTAL CATCH</b>    |                 |       |         |         |         |         |         |                   |         |         |                   |         |                      |
| no. caught            | 0.0             | 0.0   | 0.0     | 0.0     | 0.0     | 0.0     | 281     | 336               | 427     | 237     | 488               | 993     | 562                  |
| total weight          | 0.0             | 0.0   | 0.0     | 0.0     | 0.0     | 0.0     | 3,277.6 | 4,365.1           | 4,370.1 | 3,794.1 | 6,668.5           | 8,188.4 | 7,969.8              |

<sup>1</sup>Based on returned catch reports for 1977 to 1983, but includes estimated b/catch and unreported catches for 1984 to present. Only the principal derby species are reported for 1977 to 1982.

<sup>2</sup>Based on known catches of principle derby species and estimated catches of non-derby species expanded for non-reporting boats.

<sup>3</sup>Figures for blue marlin and yellowfin tuna of previous reports contained an error that has been corrected here.

<sup>4</sup>Includes 2 sailfish weighing a total of 124.3 lbs

<sup>5</sup>Includes all tuna species.



Table 4. Effort, catch, and catch rates by area for the thirteenth annual GIFD. Effort is based on the number of boat trips in which area fished was reported and includes all boats known to have fished within a given area. Effort reported as both "north and south" was divided equally into north and south. A small number catches from unspecified areas are not included.

| Area                 | Effort<br>(number of<br>boat trips) | Blue marlin |         | Catch<br>Yellowfin tuna |       | Wahoo |       | Catch rate (no. and kg./trip) |      |                       |      |              |     |
|----------------------|-------------------------------------|-------------|---------|-------------------------|-------|-------|-------|-------------------------------|------|-----------------------|------|--------------|-----|
|                      |                                     | no.         | kg.     | no.                     | kg.   | no.   | kg.   | Blue marlin<br>no.            | kg.  | Yellowfin tuna<br>no. | kg.  | Wahoo<br>no. | kg. |
| North                | 123.0                               | 63          | 3,567.3 | 46                      | 178.5 | 43    | 432.7 | 0.51                          | 29.0 | 0.37                  | 1.5  | 0.35         | 3.5 |
| NW Guam <sup>1</sup> | 121.0                               | 48          | 2,734.1 | 26                      | 123.4 | 13    | 120.7 | 0.40                          | 22.6 | 0.21                  | 1.0  | 0.11         | 1.0 |
| N. Banks             | 49.5                                | 8           | 505.6   | 14                      | 34.6  | 16    | 178.9 | 0.16                          | 10.2 | 0.28                  | 0.7  | 0.32         | 3.6 |
| NE Guam <sup>2</sup> | 66.0                                | 3           | 154.0   | 2                       | 4.8   | 12    | 111.7 | 0.05                          | 2.3  | 0.03                  | 0.1  | 0.18         | 1.7 |
| South                | 22.0                                | 15          | 993.1   | 31                      | 124.6 | 12    | 109.0 | 0.68                          | 45.1 | 1.41                  | 5.7  | 0.55         | 5.0 |
| SW Guam <sup>3</sup> | 17.0                                | 4           | 225.6   |                         |       |       |       | 0.24                          | 13.3 |                       |      |              |     |
| S. Banks             | 12.5                                | 11          | 767.5   | 31                      | 124.6 | 12    | 109.0 | 0.88                          | 61.4 | 2.48                  | 10.0 | 0.96         | 8.7 |
| Total                | 129.0                               | 78          | 4,560.5 | 77                      | 339.6 | 55    | 541.7 | 0.60                          | 35.4 | 0.60                  | 2.6  | 0.43         | 4.2 |

<sup>1</sup>Orote Pt. to Ritidian Pt.

<sup>2</sup>Tarague to Pati Pt.

<sup>3</sup>Orote Pt. to Cocos.

## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** E

**STUDY NO.:** F-1

**JOB NO.:** 2

**JOB TITLE:** Inshore Fisheries Survey

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October, 1988 to September, 1989. The total estimated inshore fisheries catch for this time period was 127.5 m.t., 99.7% of which were finfish. Hook and line was the most popular method accounting for 70.1% of the total participation\* or 39,962 participants. Drag net fishing was the most successful method in terms of catch rate, yielding approximately 4.46 kg/gear-hour and a harvest of 1.4 m.t. The seasonal fisheries accounted for 44.9% of the total harvest or 58,200 kg.

### **BACKGROUND**

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational/subsistence fishing activities have come to be based on more reliable data analysis techniques.

### **OBJECTIVES**

1. To estimate the total annual inshore participation, effort and harvest of Guam's inshore recreational/subsistence fisheries through statistically valid surveys and analysis.
2. To gather limited biological data that will add to a long-term historical data base on Guam's important inshore fish species.

### **PROCEDURES**

During FY '89, day and night "inshore participation" surveys were conducted on four randomly selected days per month. These surveys entailed making visual observations of

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\* All participation and effort statistics except total harvest exclude seasonal fisheries data.

not only participation among the various fishing methods employed, but also of the reef zones and general locations that were fished within the more readily accessible portions of Guam's coastline (Fig. 1, locations 1-71). Based on data collected during nine non-consecutive years of aerial surveys conducted between FY '63 and FY '79, approximately 85% of Guam's inshore fishing activities is known to occur within this area. The starting location for each survey was selected at random and the "circular" direction of driving was alternated between surveys. Observations were made while driving the route once without backtracking. These methods were applied for both day and night participation surveys.

In addition, four "inshore-catch" survey days were selected. During these catch days, a fisherman-intercept survey was conducted to gather catch, effort, and species composition data for both day and night fishing. The day survey covered a six-hour interval (starting at 0630 hours) and the night survey covered a five-hour interval (starting at 1900 hours). Only one of three survey regions (Fig. 1) was selected for each "inshore-catch" day and fisheries data collection was restricted to that region. However, because of infrequently used methods (i.e., drag net and surround net), representative samples were sometimes difficult to obtain. Therefore, if a particular fishing method was not observed within the selected survey area during a survey, one of the other two areas could be searched.

The FY '89 inshore harvest estimates were calculated by a computer software package known as the Guam Inshore Expansion System (GIES). The GIES utilizes formulae described in the FY '85 project report (Project No. FW-2R-22, Sub-Project F, Study No. F-1, Job No. 2).

## RESULTS

During FY '89, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 127.5 m.t. Finfish accounted for 99.7% of the total harvest, or 127.1 m.t. Aside from these two initial statements, for the purposes of comparison to past reports when catch or effort statistics of the inshore fishery are reported, the seasonal harvest (scads, manahac and fusiliers) has been deleted due to insufficient effort data to properly assess these sporadic fisheries. The finfish catch resulted from a total effort of 201,531 person-hours and 181,217.1 gear-hours. Overall, approximately 0.38 kg of fish were taken per gear-hour. Estimated participation, effort, and catch values for each fishing method are shown in Table 1. The values in Table 1 are combined estimates of separate expansions of day, night, and seasonal catch data collections. Tables 2 and 3 present the participation, effort, and catch for day and night fishing for each method.

### Effort

Hook and line fishing was, by far, the most popular method based on the total participation (combined day and night values), accounting for approximately 70.1% of the total participation. Gill netting was the second most popular method overall accounting for 6,754 participants or 11.8% of the total participation, while cast netting followed with 6,466 participants or 11.4% of the total.

The rank order for day fishing participation placed hook and line first with more than four times as many participants as any other method, 30,835 participants. Cast net and gill net placed second and third respectively with 6,465 and 4,969 participants.

Hook and line remained the most popular night fish method with 9,128 participants and 64% of night participation. The second most popular method was spearfishing with snorkel gear with 2,255 participants or 15.9% of night fishing, while gill net fishing followed with 1,785 participants or 12.6% of night fishing.

## Catch

Gill net fishing yielded the largest harvest overall of 32.2 m.t. or 45.2% of the total harvest. Hook and line fishing followed with 21.5 m.t. or 31.1% of the total harvest and cast net fishing was third with 7.7 m.t. or 11.1 % of the overall total.

Due to more than 80% of the total harvest resulting from day fishing, the rank order for day harvest is the same as that of the combined harvest. Gill net fishing yielded the largest harvest overall of 27.7 m.t. or 47.1% of the day harvest. Hook and line fishing followed with 20.2. m.t. or 34.4% and cast net fishing was third with 7.7 m.t. or 13.1 % of the day harvest.

Gill net fishing had the highest night harvest with 4.6 m.t. or 38.1% of the total night harvest. Spearfishing with snorkel gear was second with 3.8 m.t. or 31.4% of the total fishing while drag net fishing followed with 1.4 m.t. or 11.7% of the total night fishing.

## Catch Per Unit Effort (CPUE)

Gill net fishing had the highest catch per unit effort (CPUE) of 2.45 kg/gear-hour for day fishing. Surround net fishing followed with 2.34 kg/gear-hour and spearfishing with snorkel gear was third with 0.65 kg/gear-hour.

Drag net fishing had the highest catch per unit effort (CPUE) of 4.46 kg/gear-hour for night fishing. Gill net fishing followed with 1.5 kg/gear-hour and spearfishing with SCUBA gear was third with 1.11 kg/gear-hour.

The information concerning effort and harvest for methods not discussed are included in the summary Tables 1-3.

Other nearshore fisheries harvests are recorded on Guam and those results appear in the Offshore Fisheries Report (Project No. FW-2R-26, Sub-Project F-1, Study No. 1, Job No. 1) due to harvest by boat. Additionally, separate spearfishing harvests were also recorded in the offshore fisheries survey.

The species composition for the FY '89 expanded harvest for day, night, and combined are presented in Tables 4, 5, and 6. The day species composition substantiated the exceptional seasonal fisheries harvest that occurred during FY '89. The top day-caught species was *Selar crumenophthalmus*, one of several seasonal fish caught in FY '89. The top night-caught species was *Gerrus argyreus*, which was taken by gill net and spearfishing. The family Scaridae or any species in this family unexpectedly failed to rank for the second year in a row among the top ten families or species caught at night. This fact can not be attributed to over-fishing at this time but requires further investigation. The scarids are typically a major contributor to the night harvests. In general, the top ten families remained the same as those in FY '88 with shifts in rank order, but the harvest estimates for species and families in all categories except a few, dropped considerably. Some of the major shifts in rank order of harvest value for species and family groups resulted from the shift in importance of method participation. The shift in importance between fishing methods may be a function of the data collection technique and requires assessment, otherwise this indicates that fisheries effort may be shifting toward harvest methods with higher catch rates. If proven to be valid information, this could require management to prevent overfishing.



The seasonal catch of certain juvenile fishes is widely anticipated by local fishers. The catches of tiao and e'e' are fairly well represented within the expansion estimates given in Tables 1-3. During FY '89, pulses of recruiting juvenile goatfish (tiao) occurred from May through August and of juvenile jacks (e'e') from June to September.

Three specific seasonal fisheries require special mention. FY '89 marked a short (June to September) but exceptional year for scads (*Selar crumenophthalmus*), representing the largest combined and day-caught species with 56,073.2 kg. The manahac (juvenile rabbitfish) did not run in large numbers as in FY '88. In fact, FY '89 had a very small run (1,500 kg) consisting only of *Siganus spinus* during May and again in September. *Pteroceasio tile*, often mistaken for baby rainbow runner (*Elagatis bipinnulatus*), also ran in small numbers (700 kg) in March and September, but these numbers are above most years because this fish does not recruit en masse every year. The last year this fish appeared in any large quantities was in 1984. The harvest estimates for these fisheries were determined independently from the GIES system due to the sporadic nature of these fisheries.

In addition to finfish, a number of other organisms were taken from the reefs throughout the year. The estimated harvest of octopus amounted to a 1,680.7 kg and was caught at the rate of .71 kg/gear-hour. Beyond this, other methods, such as gleaning, produced an estimated 0.9 m.t. of various crustaceans, gastropods, bivalves, echinoderms and algae with a catch rate of 1.65 kg/person-hour of fishing effort. Adding the non-fish harvest brings the total island inshore harvest to 127,469.2 kg.

## Fish Weirs

Due to legal difficulties with the issuance of submerged lands permits for fish weir operations in Merizo, no permits were awarded during FY '89. Despite the absence of permits, operators continued to use weirs illegally. During this period no catch reports were submitted, making it impossible to determine harvest estimates. Due to the legal problem and increased user activity in the Cocos Lagoon, a notice to the public and the most recent former permit holders was issued in September 1989 ordering them to remove all fish weirs and associated gear by November 15, 1989.

## RECOMMENDATION

The initiation of computer stored records in FY '82 and the development of the GIES program in FY '85 has greatly reduced the amount of time needed to compile and analyze Guam's inshore fisheries survey data. Because of this, more effort has been spent to continually upgrade our data collection procedures to ensure statistical reliability. Since the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. The coastal fishing participation and range has steadily increased over recent years and therefore requires reinstituting the aerial surveys around Guam in FY '90 to update island-wide participation estimates. During FY '89, the GIES computerized expansion system was evaluated and rewritten. The new expansion and an upgrade in hardware to a Macintosh computer system will greatly enhance the analytical capabilities during FY '90. Once these changes have been accomplished an effort to systematically analyze past year's inshore data will be initiated to establish management needs. During FY '90, an effort should be made to determine the cause of the non-appearance of Scarids in the night harvest. The shift in fishing method participation should also be investigated for significance to management.

Report prepared by: Gerald W. Davis and Timothy S. Sherwood

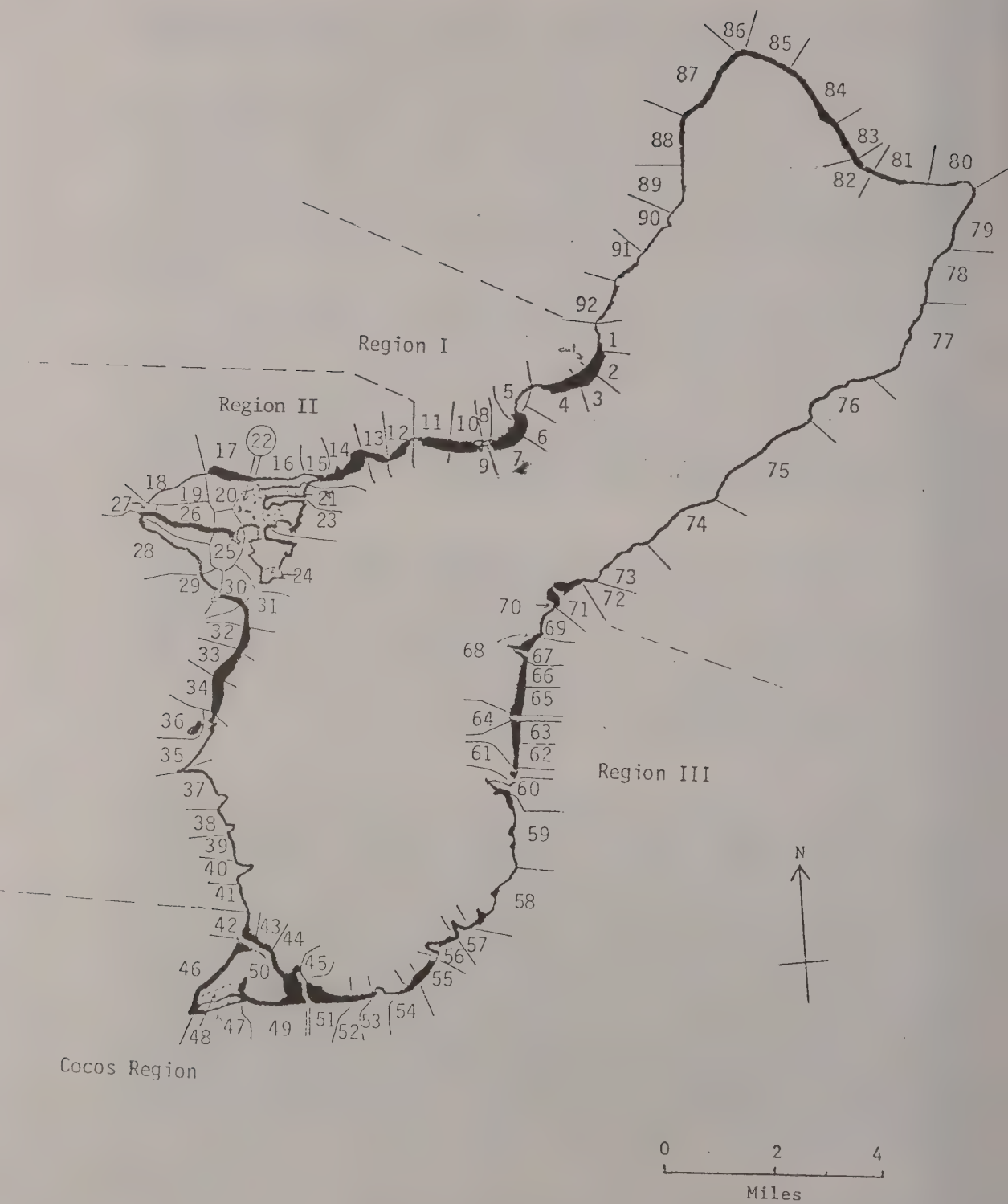


Fig. 1. Inshore Fisheries Survey Location Codes.

Table 1. Combined estimated annual (FY '89) inshore fishing participation, effort, and harvest for day and night data for all methods.

| Method            | No. of<br>Persons | No. of<br>Gear Units | No. of<br>Trips | Person-<br>Hours | Gear-<br>Hours | Catch<br>(kg) | CPUE |
|-------------------|-------------------|----------------------|-----------------|------------------|----------------|---------------|------|
| Hook and Line     | 39,962.2          | 39,243.9             | 28,437.2        | 146,554.5        | 143,262.0      | 21,464.5      | 0.1  |
| Cast Net          | 6,464.5           | 6,051.5              | 5,861.0         | 16,143.7         | 15,113.5       | 7,691.3       | 0.5  |
| Bill Net          | 6,754.4           | 3,532.2              | 3,532.2         | 27,638.4         | 14,374.6       | 32,272.2      | 2.2  |
| Surround Net      | 244.8             | 47.0                 | 47.0            | 1,210.9          | 224.5          | 524.4         | 2.3  |
| Pearlfishing (SN) | 2,511.7           | 469.5                | 1,155.6         | 7,428.2          | 7,024.7        | 4,486.9       | 0.6  |
| Pearlfishing (SC) | 287.2             | 287.2                | 221.5           | 901.7            | 901.7          | 1,001.9       | 1.1  |
| Trag Net          | 758.9             | 154.6                | 154.6           | 1,654.0          | 316.1          | 1,411.0       | 4.5  |
| Seasonal total    | N/A               | N/A                  | N/A             | N/A              | N/A            | 2,200.0       | N/A  |
| Fish totals       | 56,983.7          | 49,785.9             | 39,409.1        | 201,531.4        | 181,217.1      | 71,052.2      | 0.4  |
| Octopus           | 711.2             | 865.3                | 415.6           | 1,977.0          | 2,380.7        | 1,680.7       | 0.7  |
| Other"            | 166.3             | 166.3                | 158.7           | 567.4            | 567.4          | 936.3         | 1.7  |
| Totals            | 57,861.2          | 50,817.5             | 39,983.4        | 204,075.8        | 184,165.2      | 73,669.2      |      |

Table 2. Estimated annual (FY '89) inshore fishing participation, effort, and harvest for daytime period for all fishing methods.

| Method            | No. of<br>Persons | No. of<br>Gear Units | No. of<br>Trips | Person-<br>Hours | Gear-<br>Hours | Catch<br>(kg) | CPUE |
|-------------------|-------------------|----------------------|-----------------|------------------|----------------|---------------|------|
| Hook and Line     | 30,834.7          | 29,954.9             | 22,504.3        | 124,012.4        | 120,281.9      | 20,218.0      | 0.2  |
| Cast Net          | 6,464.5           | 6,051.5              | 5,861.0         | 16,143.7         | 15,113.5       | 7,691.3       | 0.5  |
| Bill Net          | 4,969.4           | 2,731.8              | 2,731.8         | 20,754.2         | 11,322.1       | 27,685.6      | 2.4  |
| Surround Net      | 244.8             | 47.0                 | 47.0            | 1,210.9          | 224.5          | 524.4         | 2.3  |
| Pearlfishing (SN) | 258.2             | 258.2                | 116.6           | 1,083.3          | 1,083.3        | 705.0         | 0.7  |
| Pearlfishing (SC) | 0.0               | 0.0                  | 0.0             | 0.0              | 0.0            | 0.0           | 0.0  |
| Anahac            |                   |                      |                 |                  |                | 1,500.0       |      |
| Isilier           |                   |                      |                 |                  |                | 700.0         |      |
| Fish Totals       | 42,771.6          | 39,043.4             | 31,260.7        | 163,204.5        | 148,025.3      | 59,024.3      |      |
| Octopus           | 711.2             | 865.3                | 415.6           | 1,977.0          | 2,380.7        | 1,680.7       | 0.7  |
| Other"            | 60.0              | 60.0                 | 52.4            | 94.2             | 94.2           | 250.2         | 2.7  |
| Day Total         | 43,542.8          | 39,968.7             | 31,728.7        | 165,275.7        | 150,500.2      | 60,955.2      |      |

Table 3. Estimated annual (FY '89) inshore fishing participation, effort, and harvest for nighttime period for all fishing methods.

| Method            | No. of<br>Persons | No. of<br>Gear Units | No. of<br>Trips | Person-<br>Hours | Gear-<br>Hours | Catch<br>(kg) | CPUE |
|-------------------|-------------------|----------------------|-----------------|------------------|----------------|---------------|------|
| Hook and Line     | 9,127.5           | 9,289.0              | 5,932.9         | 22,542.1         | 22,980.1       | 1,246.5       | 0.1  |
| Bill Net          | 1,785.0           | 800.4                | 800.4           | 6,884.2          | 3,052.5        | 4,586.6       | 1.5  |
| Pearlfishing (SN) | 2,253.5           | 211.3                | 1,039.0         | 6,344.9          | 5,941.4        | 3,781.9       | 0.6  |
| Pearlfishing (SC) | 287.2             | 287.2                | 221.5           | 901.7            | 901.7          | 1,001.9       | 1.1  |
| Trag Net          | 758.9             | 154.6                | 154.6           | 1,654.0          | 316.1          | 1,411.0       | 4.5  |
| Fish Totals       | 14,212.1          | 10,742.5             | 8,148.4         | 38,326.9         | 33,191.8       | 12,027.9      |      |
| Other"            | 106.3             | 106.3                | 106.3           | 473.2            | 473.2          | 686.1         | 1.4  |
| Night Totals      | 14,318.4          | 10,848.8             | 8,254.7         | 38,800.1         | 33,665.0       | 12,714.0      |      |

Table 4. FY '89 day catch composition for the top species and families harvested.

| Species                           | Harvest (kg) | %     | Family       | Harvest (kg) | %     |
|-----------------------------------|--------------|-------|--------------|--------------|-------|
| <i>Selar Crumenophthalmus</i>     | 56,073.2     | 48.75 | Scads*       | 56,073.2     | 48.75 |
| <i>Mulloides flavolineatus</i>    | 10,287.8     | 8.94  | Mullidae     | 12,262.8     | 10.66 |
| <i>Naso unicornis</i>             | 9,505.6      | 8.26  | Acanthuridae | 12,152.9     | 10.57 |
| <i>Siganus spinus</i>             | 7,385.5      | 6.42  | Siganidae    | 8,567.6      | 7.45  |
| <i>Kyphosus cinerascens</i>       | 4,678.4      | 4.07  | Lethrinidae  | 5,704.1      | 4.96  |
| <i>Gerrus argyreus</i>            | 2,450.0      | 2.13  | Kyphosidae   | 4,974.5      | 4.32  |
| <i>Lethrinus elongatus</i>        | 1,514.1      | 1.32  | Lutjanidae   | 3,031.1      | 2.64  |
| <i>Hemiramphus archipelagicus</i> | 1,773.0      | 1.54  | Gerridae     | 2,450.0      | 2.13  |
| <i>Neoniphon sammara</i>          | 1,394.8      | 1.21  | Carangidae   | 2,400.0      | 2.09  |
| <i>Liza vaigiensis</i>            | 1,360.6      | 1.18  | Mugilidae    | 2,354.3      | 2.05  |
| Total all species                 | 115,024.3    | 83.83 | Total        | 115,024.3    | 95.61 |

Table 5. FY '89 night catch composition for the top species and families harvested.

| Species                        | Harvest (kg) | %     | Family        | Harvest (kg) | %     |
|--------------------------------|--------------|-------|---------------|--------------|-------|
| <i>Gerrus argyreus</i>         | 1,716.7      | 14.27 | Acanthuridae  | 2,733.0      | 22.72 |
| <i>Mulloides flavolineatus</i> | 1,109.8      | 9.23  | Gerridae      | 1,716.7      | 14.27 |
| <i>Acanthurus triostegus</i>   | 771.2        | 6.41  | Mugilidae     | 1,587.9      | 13.20 |
| <i>Acanthurus lineatus</i>     | 725.4        | 6.03  | Lutjanidae    | 1,312.7      | 10.91 |
| <i>Valamugil engeli</i>        | 678.9        | 5.64  | Mullidae      | 1,296.5      | 10.78 |
| <i>Naso unicornis</i>          | 600.8        | 4.31  | Siganidae     | 896.0        | 7.45  |
| <i>Acanthurus literatus</i>    | 571.2        | 4.75  | Lethrinidae   | 847.3        | 7.04  |
| <i>Crenimugil crenilabis</i>   | 518.1        | 4.31  | Carangidae    | 656.6        | 5.46  |
| <i>Caranx sexfaciatus</i>      | 498.2        | 4.14  | Holocentridae | 541.4        | 4.50  |
| <i>Siganus argenteus</i>       | 476.8        | 3.96  | Engraulidae   | 239.4        | 1.99  |
| Total all species              | 12,027.9     | 63.06 | Total         | 12,027.9     | 98.33 |

Table 6. FY '89 combined catch composition for the top species and families harvested.

| Species                           | Harvest (kg) | %     | Family       | Harvest (kg) | %     |
|-----------------------------------|--------------|-------|--------------|--------------|-------|
| <i>Selar crumenophthalmus</i>     | 56,073.2     | 44.13 | Scads*       | 56,073.2     | 44.13 |
| <i>Mulloides flavolineatus</i>    | 11,397.6     | 8.97  | Acanthuridae | 14,886.3     | 11.72 |
| <i>Naso unicornis</i>             | 10,106.4     | 7.95  | Mullidae     | 13,559.3     | 10.67 |
| <i>Siganus spinus</i>             | 7,004.7      | 5.51  | Siganidae    | 9,463.6      | 7.45  |
| <i>Lethrinus elongatus</i>        | 6,067.8      | 4.78  | Lethrinidae  | 6,551.4      | 5.16  |
| <i>Kyphosus cinerascens</i>       | 4,728.2      | 3.72  | Kyphosidae   | 5,024.3      | 3.95  |
| <i>Gerrus argyreus</i>            | 4,166.7      | 3.28  | Lutjanidae   | 4,342.8      | 3.42  |
| <i>Siganus argenteus</i>          | 2,458.9      | 1.94  | Gerridae     | 4,166.7      | 3.28  |
| <i>Acanthurus triostegus</i>      | 1,996.7      | 1.57  | Carangidae   | 3,056.8      | 2.41  |
| <i>Hemiramphus archipelagicus</i> | 1,773.0      | 1.40  | Mugilidae    | 3,942.2      | 3.10  |
| Total all species                 | 127,052.2    | 83.25 | Total        | 127,052.2    | 95.29 |

\* The scads were separated from the family Carangidae due to differences in harvest method and management significance.



## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** F

**STUDY NO.:** F-1

**JOB NO.:** 3

**JOB TITLE:** Fisheries Data Processing.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

During FY '89, offshore and inshore fisheries survey data were entered onto computer files and edited for completeness and accuracy. The offshore data base for this fiscal year contains 3,446 records and the "inshore-participation" and "inshore-catch" data bases contain 1,065 and 1,404 records, respectively. The primary software packages used for data analysis were the Guam Offshore Expansion System (GOES) for the offshore fisheries survey data and the Guam Inshore Expansion System (GIES) for the inshore fisheries survey data\*. No new data entered into the data base for Job 8, "Studies of Recreationally Important Reef Fish".

### **BACKGROUND**

Guam's Division of Aquatic and Wildlife Resources (DAWR) has been collecting fisheries information over the past 21 years (with only the last twelve years of data being reliable) and, as a result, an enormous amount of fisheries management data has been accumulated. Computers have been used over the past five years by DAWR to store and analyze this data. DAWR personnel, working closely with the National Marine Fisheries Service (NMFS), have developed and purchased programs for analyzing the Division's offshore and inshore fisheries survey data.

In FY '83, a program entitled the Guam Offshore Expansion System (GOES) was developed based on the current practices of offshore data analysis and, in FY '85, a Guam Inshore Expansion System (GIES) was completed and tested for errors. Since this time, all data collected for the offshore and inshore fisheries surveys have been analyzed through the use of these two programs.

Job 3, Fisheries Data Processing, has been jointly funded by the U.S. Fish and Wildlife Service, NMFS, and the Western Pacific Regional Fisheries Management Council.

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\*The "Guam Tournament" module for the GOES was not used in FY '89 due to a change in the keeping of the boat record logs. Derby totals for FY '89 are estimates based on expanded data. Details are given in the Annual Report for the Guam International Fishing Derby (GIFD).

## OBJECTIVES

1. Computerize the DAWR's offshore and inshore marine fisheries data and transfer the finalized fisheries data files and reports to NMFS personnel in Honolulu, Hawaii for regional application.
2. Provide technical assistance to DAWR staff biologists in the form of efficient statistical analysis and report generation.

## PROCEDURES

Guam's offshore fisheries survey data are analyzed by a system of computer programs known as the GOES. This programming package is a 5-step system that summarizes, sorts, and statistically expands the survey data to produce monthly and annual catch, effort, and species composition estimates. Two proportionality constants and a "total participation boat count" are calculated and manually entered into the expansion module by the user. Reports are generated by the GOES that give a breakdown of the estimated offshore harvest by gear type on a monthly and annual basis. Also, an estimated harvest by species is generated for each gear type with a corresponding percentage of the total catch for that gear type.

Guam's inshore fisheries survey data are analyzed by a programming package known as the GIES. The GIES is a 4-step system that relies on two sets of survey data to determine an annual inshore estimated harvest. These two sets of data are referred to as "inshore-participation" and "inshore-catch". "Inshore-participation" data consists of fishermen and gear counts obtained by biological aides when driving around the island and making observations on fishing activity within the fringing reef. "Inshore-catch" data are obtained by fishermen-intercept interviews that usually occur within a predetermined survey region. These data consist of a total catch and catch by species for each interview. Because of the apparent differences in participation and catch-per-unit-effort (CPUE) of the various gear types between daytime and nighttime fishing, a fisheries survey is conducted during each of these two time periods and the data are analyzed separately. Also, data are collected during the seasonal harvest of juvenile rabbitfish (*Siganus sp.*) and bigeye scad (*Selar crumenophthalmus*), but, because of the dissimilarities between the seasonal fisheries and the routine inshore fisheries, the two are analyzed separately.

## RESULTS

### Offshore Fisheries Survey Data Base Management

The DAWR's offshore fisheries survey data for FY '89 were entered onto computer files and edited for completeness and accuracy. The total number of records for the FY '89 offshore data base is 3,446. This brings the total number of historical and current offshore records to 24,171. Since the FY '89 GIFD data has not been entered onto the data base, the total number of fishing derby records remains at 1,986.

Based upon the expansion calculated by the GOES, the estimated islandwide offshore harvest for FY '89, including the GIFD results, is about 261.8 metric tons. For more detailed information, see Job 1, "Offshore Fisheries Survey."

### **Inshore Fisheries Survey Data Base Management**

The FY '89 DAWR inshore fisheries survey data were entered onto two data bases. The "inshore-catch" and the "inshore-participation" data bases for this fiscal year contain 1,404 and 1,065 records, respectively. This brings the total number of historical and current "inshore-catch" records to 24,077 and the "inshore-participation" records to 17,030.

Based upon the expansion calculated by the GIES, the total FY '89 harvest estimate for Guam's inshore fisheries, combining day fishing, night fishing, and seasonal fishing, is approximately 127.5 metric tons. For more detailed information, see Job 2, "Inshore Fisheries Survey".

### **Other Fisheries Data Bases**

During FY '87, a data base was established for the storage and dissemination of reef fish data used for Job 8, "Studies of Recreationally Important Reef Fish." No new records have been entered as analysis has not been completed on the historical records. The total number of records contained in this data base remains at 1,687.

### **RECOMMENDATION**

Data processing has become a valuable asset to the many research projects currently undertaken at DAWR. Data storage and retrieval, data analysis, and report generation has improved greatly since the installation of a computer system, but this system is becoming old and undependable. It is therefore recommended that this office acquire new computer hardware and software to continue this job and update the expansion systems.

Report prepared by: Timothy S. Sherwood

## PROJECT SEGMENT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-26  
SUB-PROJECT NO.: F  
STUDY NO.: F-1  
JOB NO.: 8

JOB TITLE: Studies of Recreationally Important Reef Fish.

PERIOD COVERED: October 1, 1988 to September 30, 1989

### SUMMARY

During FY '89, data collection was continued toward the completion of growth and fecundity studies of the rabbitfish, *Siganus spinus* and the goatfish, *Mulloides flavolineatus*. Sampling was conducted throughout the year, however adequate numbers of specimens have not yet been collected to gain all the information necessary to complete this work. Statistical analysis was begun on *Lethrinus harak*.

### BACKGROUND

Studies on the population dynamics of recreationally important inshore reef fish were initiated in FY '82 but suspended that same year because of competing work priorities resulting from a reduction in staff. In FY '84, a fisheries biologist was hired to continue working on this study.

During FY '84, several species of fish were identified as recreationally important reef fish on Guam (*Acanthurus triostegus*, *Caranx melampygus*, *Mulloides flavolineatus*, *Selar crumenophthalmus*, *Siganus spinus* and *Lethrinus harak*). The determination was based on harvest information obtained from the Division of Aquatic and Wildlife Resources creel survey data (FY '80 to FY '84). Studies were initiated on *S. spinus*, *M. flavolineatus* and *Lethrinus harak*. Both *S. spinus* and *M. flavolineatus* are harvested throughout the year as sub-adults, adults and seasonally as juveniles. *L. harak* is not specifically harvested as a juvenile, rather the harvest pressure is placed on sub-adults and adults. Initial field collections were made during FY '84. During FY '85, aspects of the reproductive biology of these selected species were investigated. They included sex ratio, spawning, maturation, and preliminary fecundity studies. Analysis was concentrated on *S. spinus* and *M. flavolineatus*. These two species were chosen because the sex is fixed (they are gonochotistic) and the biology less complex and analysis simpler than *L. harak* (which may be hermaphroditic, ie. the sex changes with growth). Both species exhibit extended spawning periods punctuated by distinct peaks in activity. Lunar cycles influence timing of spawning which centers around the full moon. During FY '86, this job was inactive because of shifts in staff positions. During FY '87, the job was reactivated and analysis of existing data was conducted. During FY '88, further field collections were conducted to expand the data base on fecundity and data analysis was continued.



## OBJECTIVE

To obtain sufficient information on the biology and life history of selected reef fish species to permit evaluation of the need for stock management.

## PROCEDURES

During FY '89, field collections were made to determine growth and fecundity of the rabbitfish *S. spinus* and the goatfish *M. flavolineatus*. Observations were continued on the recruitment and fishing effort for these fish. Information obtained was added to the existing data base for future analysis. Data collected on *L. harak* was placed in analytical format and general descriptive statistics run on this information.

## RESULTS

### *Siganus spinus* and *Mulloides flavolineatus*

Although collections were made throughout the year, adequate samples have not been obtained to allow for accurate statistical analysis or description of growth and fecundity at this time. Growth analysis (rate of change in length and weight) requires a time series sample of cohort individuals taken from recruitment through maturity until individuals attain maximum harvested size and beyond, if possible. Fecundity provides a quantitative estimate of spawning potential. Individual fecundity is determined by counting the number of ripening oocytes and mature eggs just before spawning. Egg counts are taken from several fish within a size class and an average determined. Known fecundity for a range of size classes through a population is used to estimate total production.

### *Lethrinus harak*

Preliminary data analysis provided some information necessary for management considerations for example, length/weight relationships, sample population length frequency distribution, size at first maturity and sex ratio. Visual analysis of maturing and mature gonads did not reveal sequential hermaphroditism in this species.

## RECOMMENDATIONS

### *Siganus spinus* and *Mulloides flavolineatus*

The growth and fecundity study should be completed, final analysis conducted and recommendations for management formulated.

### *Lethrinus harak*

Data analysis should be continued and field collections initiated for growth and fecundity studies. Particular attention should be given to investigation of the possible hermaphroditism since this is common throughout the Lethrinidae family. Recommendations about management should be made.

Job 8 should be continued to initiate the studies on other species of inshore reef fish identified as being recreationally important on Guam and to incorporate all available analytical techniques useful for determining key factors which are useful for species and habitat management.

Report prepared by: Gretchen R. Grimm

## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT:** E

**STUDY NO.:** 1

**JOB NO.:** 11

**JOB TITLE:** Biomass and Stock Assessment

**PERIOD COVERED:** October 1, 1988 to September 30, 1989.

### **SUMMARY**

Preliminary transects were established at two reef flat or shallow lagoon sites: Ypao Beach near the Hilton Hotel and Luminao Reef off the Glass Breakwater. In addition, a preliminary reconnaissance of a deepwater reef ( $\geq 15$  m) within Apra Harbor was conducted, but no transects were run there. Results of a limited number of tests of three transecting methods conducted at Ypao Reef indicate that there is up to a 10-fold difference in observed density between methods. Further tests are needed to determine which method best suits a particular area, and which method is the overall best for all areas.

### **BACKGROUND**

Effective management of fisheries resources requires an understanding of the effects of fishing pressure on the stocks of target species as well as an understanding of their population dynamics, life histories, ecology, and limits of distribution within the environment. Although harvest estimates for most of Guam's reef fish species are available, little quantitative information on their standing stocks is available. Limited surveys were conducted a number of years ago, but none of these were islandwide in scope, none sampled a complete range of reef zones or habitats, and no attempt was made to obtain quantitative or adequate qualitative information on populations below the practical limits of scuba diving. As the fishing pressure on Guam's recreational reef fishes continues to increase, it is increasingly necessary to obtain quantitative as well as qualitative information on the standing stocks of these fishes and those they interact with in a representative range of reef zones and habitats and, if possible, in relatively unexploited as well as highly exploited areas.

### **OBJECTIVE**

To estimate the biomass of recreationally important fishes harvested at Guam and to assess the general status of their stocks in relation to fishing pressure currently exerted on them.

### **PROCEDURES**

Within each reef zone at each site, the following three types of counts of reef fishes were planned: (1) visual transects consisting of timed 10-minute replicate counts of all roving species within 5 m of the observer, (2) 5-minute replicate counts of all territorial and non-roving species, and (3) counts to the limit of "recognition visibility" of all individuals of "observer shy" or rare species. For the purposes of this study, only species of special

interest as important food fishes or environmental indicators will be counted on some or all transects. Counts of these species may also be broken down into discrete size classes. The species selected and size classes used will be determined after the final selection of methods and sites has been made. It should be noted that several new methodologies for visual counts made by scuba divers have appeared in the literature in recent years (eg. Bohnsack and Bannerot 1985); the potential use of these is being investigated. Depending on the results of field trials, one or more of these may be selected over one or more of the current methods. Other methods that may yield valuable information beyond the reach of visual transects made by scuba divers are also being investigated. These include the use of a remote video camera (operated by the University of Guam Marine Laboratory; this method may eliminate the bias caused by observer-shy species leaving the area of a scuba diver) and a deep-diving submersible. Both of these methods should enable certain kinds of counts to be made to the lower depth limit of the species being investigated.

The following three methods were tested at one or more sites for their utility in determining population densities: 50x10 m permanent transects (3 transects; 1 set of counts);  $\geq 80 \times 10$  m permanent transects (2 transects; 2 sets of counts); 10 minute timed counts (2 stations, 2 sets of counts); and stationary 7.5 m diameter cylinders (in which fishes are counted in the cylinder of water above a 7.5 m diameter circle around the observer (4 stations; 1 to 3 sets of counts). Approximate elapsed times ( $\pm 0.5$  min.) for most transects were recorded to determine the degree of variability in area covered per unit of time.

## RESULTS

During FY '89, test transects were made at two sites and at a third site, a preliminary reconnaissance was conducted and species list made. However, additional work will be required to determine which methods will work best for these sites, and lack of a seaworthy vessel made it impossible to establish transect stations beyond the reef margin. It is anticipated that the recent acquisition of a seaworthy vessel will make it possible to begin collecting baseline data at additional sites as well as the current sites, both inside and outside of the reef margin.

### Site descriptions

#### Ypao:

This site consists of the western third of Tumon Bay, from Ypao Point east to a small vegetated rubble island. A wide intertidal reef flat extends from the west shore of the island southwest to the base of a cliffline. This reef flat encloses a permanent shallow moat which extends to the northeast end of Tumon Bay. The shoreward side of this moat consists primarily of fine sand with scattered small pieces of coral rubble, rocks and living coral heads. Much of this area has been dredged to a depth of approximately 3 m to provide deeper areas for swimming and water sports. Most of the moat adjacent to the intertidal flat consists of scattered to extensive patches of living corals growing on a hard bottom at depths of 1 to 2 m. Test transects were run only in the subtidal moat.

One hundred and five species of fishes were observed within the subtidal moat. Important food fishes included groupers, jacks, emperors, mojarras, goatfishes, wrasses, parrotfishes, mullets, surgeonfishes, and rabbitfishes. On every visit, large aggregations of goatfishes, *Mulloidae flavolineatus* and *M. vanicolensis*, were observed in sand-bottomed holes and channels among dense stands of coral, and large numbers of the surgeonfish *Acanthurus triostegus* were observed roving in the vicinity. The presence of a moving diver caused the goatfishes to vacate their sheltering areas and move about.



Constantly moving clumps of fishes made it difficult to obtain accurate counts for many of the economically important species.

#### Luminao Reef:

A detailed description of the area and its fishes may be found in Myers (1982). The site chosen for this project is located a few hundred meters to the east of site A.

#### Gabgab second reef (an unnamed coral pinnacle in Apra Harbor):

This is a large peanut-shaped mound located approximately 120 m northeast of the reef margin to the east of Gabgab Beach. The mound rises steeply from the harbor bottom at a depth of about 35 m to within 12 m of the surface. The top of the mound is relatively flat and the sides slope gently near the top to about 40° at depths below 25 m. Most of the upper surface consists of living coral, primarily *Porites* (*Synaraea*) *rus*, with extensive patches of *Galaxea fascicularis*, *Acropora vaughani*, and other corals. An extensive area of coral rubble is present at the western node of the reef and another large section of living corals to the east of this rubble patch has recently been extensively damaged by a mislaid anchor chain of a Navy mooring buoy. The distance of the reef from the nearest shoreline makes it relatively undisturbed by spearfishermen. However it is used extensively by commercial and recreational interests for non-consumptive purposes, and several times daily for sight-seeing excursions by the passenger submersible Atlantis. The isolated position of this reef and small size make it possible to visually cover the entire reef top in one dive and prevent many species from leaving the area.

Eighty-one species of fishes were observed on one dive of 50 minutes duration. Recreationally important foodfishes were well-represented, including large groups of the goatfishes *Mulloides flavolineatus* and *M. vanicolensis*, parrotfishes (primarily *Scarus schlegeli*), and the rabbitfish *Siganus argenteus*, as well as smaller numbers of other species of goatfishes and parrotfishes, groupers, jacks, snappers, and emperors. It is anticipated that the results of conventional transecting will be highly variable since the most abundant fishes were highly clumped and highly mobile. Total population estimates based on standardized swims that cover the entire reef top may be the best method for this site.

#### Test transects:

Although considerable differences in density were observed between counts and between sites, the density of fishes observed between methods at Ypao varied by nearly an order of magnitude (Table 1) with total number ranging from 9 to 81 per 100 square meters. The three 50x10 m transects consistently yielded the fewest numbers of fishes, while transects of 90x10 m or more and 7.5 m cylindrical counts both yielded much higher, though highly variable numbers. This was due to the bulk of the fishes of interest being highly clumped in distribution. This problem was more severe at the Ypao site than the Luminao site, particularly for the 7.5 m cylinder method. The only solution to this problem is to obtain a large number of replicates. The results of timed 10-minute counts at Luminao reef consistently covered an area of 800 to 1,000 square meters, whereas the results at Ypao were less consistent due to a highly clumped distribution of fishes. In situations where a large number of fishes occur in a small, well-defined space, a reasonably accurate estimate of overall density may be impossible unless the size of the entire site is considered. In that case, a standardized dive in which a large area of known size is covered and all individuals of selected species are counted, may be the only appropriate method.

## RECOMMENDATIONS

It is recommended that this project remain active at a low level until methodologies have been reviewed and selected, and that the scope of the project be scaled down to a few representative sites around the island.

## LITERATURE CITED

Bohnsack, J. A., and S. P. Bannerot. 1986. A stationary visual census technique for quantitatively assessing community structure of coral reef fishes. NOAA Tech. Rep. NMFS 41, 15 pp.

Myers, R. F. 1982. Fishes. In Assessment of the shoalwater environments in the vicinity of the proposed OTEC development at Cabras Island, Guam. R.H. Randall and L.G. Eldredge, eds. Univ. of Guam Marine Lab. Tech. Rep. No. 78, ii, 208 pp.

Report prepared by: Robert F. Myers

Table 1. Comparison of results of limited transect tests during FY 89. Counts represent selected species of foodfishes in standardized size classes\*.

| Method & Station**                                  | Ypao                                    |       |      |       |        | Luminao                                 |         |            |      |       |        |       |  |
|-----------------------------------------------------|-----------------------------------------|-------|------|-------|--------|-----------------------------------------|---------|------------|------|-------|--------|-------|--|
|                                                     | number of fishes per 100 m <sup>2</sup> |       |      |       |        | number of fishes per 100 m <sup>2</sup> |         |            |      |       |        |       |  |
|                                                     |                                         | small | med  | large | v. lg. | total                                   | Station | small      | med  | large | v. lg. | total |  |
| <u>7.5 m dia. cyl. ( 555 m<sup>2</sup>)</u>         |                                         |       |      |       |        |                                         |         |            |      |       |        |       |  |
| Sta. A                                              | 1st                                     | 0.5   | 45.8 | 0.7   | 0.0    | 47.1                                    | Sta. A  | 0.2        | 4.5  | 2.5   | 0.0    | 7.2   |  |
|                                                     | 2nd                                     | 0.0   | 4.7  | 0.2   | 0.0    | 4.9                                     | Sta. B  | 2.5        | 5.0  | 2.0   | 0.0    | 9.5   |  |
|                                                     | 3rd                                     | 0.0   | 4.7  | 0.3   | 0.0    | 5.0                                     |         |            |      |       |        |       |  |
| Sta. B                                              | 1st                                     | 0.9   | 9.3  | 13.5  | 0.0    | 23.7                                    |         |            |      |       |        |       |  |
|                                                     | 2nd                                     | 0.3   | 3.6  | 52.6  | 0.0    | 56.6                                    |         |            |      |       |        |       |  |
|                                                     | 3rd                                     | 0.0   | 3.9  | 38.8  | 0.0    | 42.8                                    |         |            |      |       |        |       |  |
| mean                                                |                                         | 0.3   | 12.0 | 17.7  | 0.0    | 30.0                                    |         | 1.4        | 4.8  | 2.2   | 0.0    | 8.3   |  |
| <u>50x10 m transects</u>                            |                                         |       |      |       |        |                                         |         |            |      |       |        |       |  |
| Sta. A                                              |                                         | 2.9   | 5.0  | 0.8   | 0.0    | 8.7                                     |         | not tested |      |       |        |       |  |
| Sta. B                                              |                                         | 1.4   | 7.3  | 3.8   | 0.0    | 12.5                                    |         |            |      |       |        |       |  |
| Sta. C                                              |                                         | 0.0   | 6.0  | 2.9   | 0.0    | 8.9                                     |         |            |      |       |        |       |  |
| mean                                                |                                         | 1.4   | 6.1  | 2.5   | 0.0    | 10.0                                    |         |            |      |       |        |       |  |
| <u>Long transects and area covered</u>              |                                         |       |      |       |        |                                         |         |            |      |       |        |       |  |
| Sta. A:                                             | 1st                                     | 0.4   | 13.7 | 2.7   | 0.0    | 16.8                                    |         | not tested |      |       |        |       |  |
| (150x10 m)                                          | 2nd                                     | 0.1   | 3.1  | 22.6  | 0.1    | 25.8                                    |         |            |      |       |        |       |  |
| Sta. B:                                             | 1st                                     | 0.8   | 8.1  | 5.6   | 0.0    | 14.4                                    |         |            |      |       |        |       |  |
| (90x10 m)                                           | 2nd                                     | 0.0   | 8.3  | 71.9  | 0.3    | 80.5                                    |         |            |      |       |        |       |  |
| mean                                                |                                         | 0.3   | 8.3  | 25.7  | 0.1    | 34.4                                    |         |            |      |       |        |       |  |
| <u>10-minute swims and approximate area covered</u> |                                         |       |      |       |        |                                         |         |            |      |       |        |       |  |
| not tested                                          |                                         |       |      |       |        | Sta. A (80x10 m)                        | 2.5     | 8.9        | 5.1  | 0.4   | 16.9   |       |  |
|                                                     |                                         |       |      |       |        | (100x10m)                               | 2.5     | 10.7       | 2.5  | 0.5   | 15.8   |       |  |
|                                                     |                                         |       |      |       |        | Sta. B (100x10m)                        | 0.0     | 11.7       | 8.3  | 0.0   | 20.0   |       |  |
|                                                     |                                         |       |      |       |        | (100x10m)                               | 0.0     | 16.8       | 6.5  | 0.1   | 23.4   |       |  |
| mean                                                |                                         |       |      |       |        |                                         |         | 1.3        | 12.0 | 5.6   | 0.3    | 19.0  |  |

\*Observed fishes were assigned the following size classes: small = 0-7.4 cm FL; medium (med) = 7.5-14.9 cm FL; large = 15-24.9 cm FL; and very large (v. lg.) ≥ 25 cm FL; species selected are not indicated here because the final selection has not yet been determined, but the same species were counted consistently in all of these tests.

\*\*The notations "1st", "2nd" and "3rd" refer to replicate counts which may or may not have been taken on the same dates.

## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26  
**SUB-PROJECT NO:** E  
**STUDY NO.:** E-1  
**JOB NO.:** 12

**JOB TITLE:** Establishing Permanent Marine Conservation Areas on Guam.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

The recent increase in total number of hours fishing and a decreasing catch rate shows that severe pressure is being exerted on the inshore fisheries. The Division of Aquatic and Wildlife Resources recommends the establishment of a Marine Conservation Area (MCA) in Tumon Bay to relieve some of this pressure and ease user conflict.

### **BACKGROUND**

In recent years, marine sanctuaries have become an effective tool for managing tropical multi-species fisheries. A sanctuary reserves an area for the protection of marine resources for the enjoyment of non-consumptive recreational users and to provide refuge for breeding stocks that will replenish the island reefs with juveniles.

The DAWR's data base shows that the total harvest for Guam's inshore fishery has decreased by 20% (not including seasonal fisheries) over the past three years (FY '85 to FY '87). One reason for this decline is the increase in user conflicts. A prime example of this conflict is East Agana Bay. This bay is a popular fishing area for the local residents. Over the past few years, a great deal of animosity has come about between the local fishermen and the jet ski operators trying to utilize the same area.

Another major reason for the decrease in harvest is the large amount of pressure that the inshore fisheries is under. The total number of hours that people have been fishing has almost doubled from 161,602 hours in FY '84 to 300,861 in FY '87. Along with this increase, the average catch per hour dropped from 0.55 kg. to 0.42 kg. in the same period (not including seasonal fisheries), showing that these fisheries are under severe pressure. Many places have used the sanctuary concept as a way of reducing user conflicts and relieving the pressure that is exerted on the recreational fisheries. An example of a successful sanctuary is Hanauma Bay, Hawaii. In the late 60's, Hawaii experienced a large increase in tourism and heavy fishing pressure. As a result, Hawaii designated Hanauma Bay as a marine life conservation district (sanctuary) where consumptive use of marine life is prohibited, including hook and line, spearfishing, and the collecting of any marine organisms. This area also prohibits all boating activity (including boardsailers, motorboats and jet skis). These prohibitions have lowered the user conflict of the area and, appears to have increased the fish stocks of the area. Out of all areas compared by Kimmerer and Durbin (1975), Hanauma Bay had the highest fish abundance (2320



fish/1000 m<sup>2</sup>) and biomass (6718 kg./hectare). This area has become so popular that in 1975 it attracted over 20,000 visitors per month.

A sanctuary should be established in an area that has a broad habitat diversity representative of the island's reefs, and is equally accessible to residents as well as visitors. It should be in an area that will benefit recreational users as well as the fishermen of Guam. Conflicts of interest between user groups should be kept to a minimum while surveillance and enforcement should be vigorously adhered too. Safety is also a major factor in selecting an area for a sanctuary as novice swimmers and snorkelers should be in an area that is relatively free from hazards.

## OBJECTIVES

To study the establishment of one or more MCA's in order to provide a refuge for recreationally important fish so they may grow, mature, and reproduce to increase stock health and recruitment.

## PROCEDURES

The following criteria were used for selecting an area for the establishment of a conservation area. An MCA should be established in an area that has a broad habitat diversity that is representative of the islands reefs, and is equally accessible to both residents and visitors. It should be in an area that will benefit recreational users as well as the fishermen of Guam, preferably in an area with decreasing fishing pressure. Conflicts between user groups should be minimized while surveillance and enforcement should be vigorously adhered too. Safety is also a major factor in selecting an area for a sanctuary as novice swimmers and snorkelers should be in an area that is relatively free from hazards. The preliminary list of sites for the establishment of an MCA were Cetti Bay, Cocos Lagoon, the "Glassbreak water" (including "Dogleg Reef" and Luminao Reef), and Tumon Bay. Tumon Bay was selected over the other areas for the reasons described below.

A formal proposal for the establishment of a Marine Conservation Area in Tumon Bay was prepared and circulated to other government agencies for review and comment. Comments received were favorable. This proposal is summarized below.

## RESULTS

### Tumon Bay Marine Conservation Area

Tumon Bay, located on the northwest coast of Guam, is a broad crescent shaped limestone platform with the cliffs of Ypao Point bordering on the southwest and "Gun Point" on the northeast. The area surrounding the bay has become a popular area for both local residents and visitors.

**Representativeness** - The bay is two (2) miles in length and the reef platform is up to 1450 feet in width. The bay has seven (7) major habitat types (inner reef flat, outer reef flat, reef margin, reef front, submarine terrace, seaward slope, and channels). See Figure 1 and Table 1.

For a conservation area to be effective, it must protect fish during the juvenile and adult stages of their life. Once the fish have settled out on the reef, the protected area should be large and diverse enough to offer habitat through their development from juvenile to adult. The habitats in Tumon Bay are diverse enough to offer refuge for a wide range of immature as well as mature fish.

## **Key Factors Concerning Tumon**

**Diversity** -The coral diversity of Tumon is very high. Randall (1972) listed a total of 146 species representing 36 genera on transects going from the shoreline out to the reef front. The fish diversity has been described by Amesbury (1978) which noted 47 species from 19 genera that occur in Tumon

**Accessibility** -Tumon is within the major population center on Guam. There is a major road that parallels the beach and is about 1000 feet from the high water mark. There are also many side roads that provide access to the shoreline. The water is fairly calm throughout the year but, infrequently, storms passing near Guam can generate strong currents within the bay (Figure 2).

**Recreational Importance** -This bay has become a center for recreational activity for both residents and visitors. However, the importance of this area to inshore recreational fisheries has been diminishing over the past five years. The total catch from Tumon Bay is currently 10% of the total annual harvest of Guam. Tables 2,3 and 4 show the total harvest and fishing participation for Tumon Bay. These tables show that over a five-year period, from FY '83 to FY '87, the total catch has dropped by 43%, person-hours dropped by 51%, and gear-hours have dropped by 86%. The decrease in harvest reported over the last five years is expected to continue into the near future and, therefore, the overall catch from Tumon is expected to decrease in importance to the total annual harvest of Guam. The effect of making Tumon Bay a conservation area would be a great benefit to the fisheries of Guam. It would preserve the remaining diversity of the fish population and allow this population to increase to the point where Tumon becomes a source of recruitment for other areas. This is supported by Alcalá (1979) who showed the fish populations on reefs adjacent to sanctuaries may significantly increase. Also, the fishing methods used in Tumon Bay are methods that are used island-wide and, therefore, if fishing is restricted in Tumon, these methods could be practiced as effectively elsewhere on the island.

**Conflicts of Interest** - The DAWR's inshore fishing database shows a decline in fishing participation in Tumon Bay. Although, this could be due to several different reasons, the most obvious is the conflict between fishing and other recreational activities. Competing recreational activities decrease the harvest from Tumon by disrupting both the fish and the fishermen. As this area becomes more developed, the conflicts between fishing and other recreational activities will only increase. Establishing an MCA in this area would benefit both groups. It has been shown that the reproductive capability of a protected multi-species population greatly influences the populations of fish on surrounding reefs (Alcalá, 1979). The fishermen would thus benefit from protecting an area that maintains a large multi-species population with high reproductive capability. Tumon would attract such activities as diving, snorkeling, and swimming from other areas. By doing so, the user conflict in other areas should be reduced.

**Surveillance and Enforcement** - Surveillance and enforcement are important factors for a successful conservation area. Tumon Bay has the infrastructure to provide for strict enforcement of laws and regulations necessary for a conservation area. This infrastructure includes major and minor roads that provide easy access to the beach. The area is already patrolled by Guam Police Officers and lifeguards, and is easily observed from the beach and surrounding cliffs. The boundaries for a conservation area should be prominent and easily identified. In Tumon, the

Department of Agriculture recommends "Gun Point" and Ypao Point as the east and west boundaries respectively. The northern boundary should be the reef margin and the southern boundary should be the mean high tide mark on the shoreline. Enforcement of the regulations for this marine conservation area should be the responsibility of DAWR's Conservation Officers, Guam Police Department, Department of Parks and Recreation Rangers, and all other peace officers.

**Safety** - The safety of the area is as important as surveillance. Lifeguards are already present at some beaches along Tumon Bay. Although the currents going through the bay can sometimes be swift and strong, they are usually weaker than other areas under the same conditions (this is because Tumon is on the lee of the island and protected by high cliffs and a barrier reef). The lifeguards should have enough training to know where and when strong currents are present in order that they can inform the public. The water in this area is usually waist to chest deep, so it is shallow enough for the safety of novice swimmers and snorkelers. Signs will need to be erected along the beach to explain the boundaries, regulations, and dangerous marine life present in the area. Brochures explaining the regulations and dangerous marine life should be printed and distributed to all hotels for placement in rooms, as well as to the general public.

**Benefits to Fishermen** - The major benefit to fishermen is increased catch on adjacent reefs. Although Tumon will be restricted to fishing, the MCA will provide a protected area where important recreational fish can mature and reproduce.

Many fish utilize a wide variety of habitats throughout their life cycle. The fish known locally as e'e' (*Caranx* sp.) is a good example of this. E'e' are juvenile jacks that have newly recruited onto the reef. One reason for this recruitment is a change in diet, from micro-invertebrates (while at sea) to small crustaceans and fish (which are plentiful along the shoreline). As these fish mature, they move from the shoreline into deeper water and take up residence on the outer reef margin as adults. During the reproduction phase, eggs are released and sink. After a few days, larvae hatch from the eggs, drift to sea, and begin to feed on micro-invertebrates. The development of the larvae takes from 30 to 60 days after which these fish then return to the reef and start to feed on small crustaceans, thus, restarting the cycle.

A conservation area would protect many fish from recruitment through adult stages of their life cycle. Initially, fish populations in the conservation area would increase to the limits of available food and space. Once a maximum is obtained, the conservation area could sustain these populations and provide a consistent supply of larvae to other island areas. After a short time, the adjacent areas should show an increase in recruited fish available for the fishermen to harvest.

The prime benefit for people other than fishermen would be a place to enjoy water activities with low user conflict and an area for education on marine organisms and the reefs of Guam.

## RECOMMENDATIONS

One of Guam's most valuable natural resources are the surrounding coral reefs and associated fisheries. In an effort to maintain and enhance these fisheries, legislation needs to be created that will establish a Marine Conservation Area in Tumon Bay.



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Report prepared by: Tim Sherwood



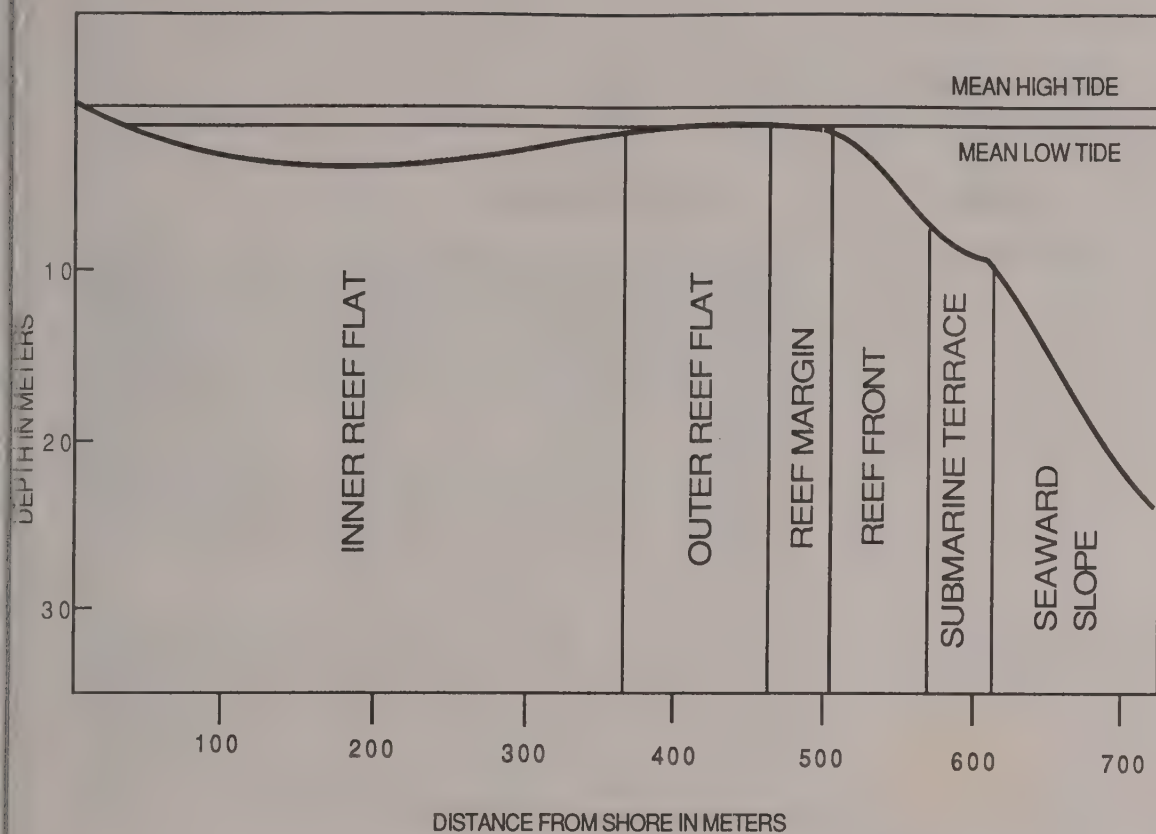


FIGURE 1. CROSS SECTION EXAGGERATION OF TUMON BAY WITH REEF ZONES LABELED.

Table 1. Description of Reef Zones at Tumon.

| <u>ZONE</u>              | <u>DESCRIPTION</u>                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inner Reef Flat (IRF) -  | ranges in width from 350 meters to 380 meters. Sand and gravel are common along the inner portion (shoreward) with coral-algae-mollusc rubble and boulders common on the outer half (seaward). The area is generally flat and has a few cracks and holes. This area also contains the moat, a depressed area of the inner reef flat that is covered by water during low tide.                                                            |
| Outer Reef Flat (ORF) -  | this area is exposed during low tide and is bounded on the shoreward side at low tide by water trapped in the moat and on the seaward side by the reef margin. The outer reef flat appears as a flat limestone pavement with scattered boulders and larger rocks that are broken from the reef margin and tossed up on the reef flat by storm waves.                                                                                     |
| Reef Margin (RM) -       | the seaward edge of the reef flat platform and is constantly awash even at low tide. The seaward edge is very irregular and it is cut at right angles by short surge channels. The inner portion of the reef margin is irregular due to the presence of small knobs, pinnacles, holes and pools. Shallow extensions of the longer surge channels cut though the inner half of this zone and terminate in small pools 1 to 2 meters deep. |
| Reef Front (RF) -        | the extreme seaward edge of the reef platform. This is where the reef margin abruptly increases in depth and degree of slope. The seaward boundary of the reef front usually coincides with the 6 meter submarine terrace. The terrace separates the reef front slope from the seaward slope.                                                                                                                                            |
| Submarine Terrace (ST) - | a noticeable flattened region when compared to the reef front and seaward. This terrace begins at the 6 meter contour and continues to the 18 meter contour where a sharp increase in the slope marks the beginning of the seaward slope.                                                                                                                                                                                                |
| Seaward Slope (SS) -     | begins where the slope of terrace abruptly increases in slope from 30 to 60 degrees. The average width of this zone is 80 meters with a second submarine terrace at a depth of 30 to 35 meters.                                                                                                                                                                                                                                          |
| Channels -               | there are two major channels that are present at Tumon. The boat channel is located off San Vitores beach and the second is immediately seaward of the small islet. These channels serve as refuge for larger fish.                                                                                                                                                                                                                      |

Table 2. Total Catch by Method for Tumon Bay FY '83 to FY '87 (In Kilograms).

| <u>METHOD</u> | <u>FY' 83</u> | <u>FY' 84</u> | <u>FY' 85</u> | <u>FY' 86</u> | <u>FY' 87</u> |
|---------------|---------------|---------------|---------------|---------------|---------------|
| HOOK & LINE   | 1263.7        | 387.8         | 283.1         | 171.1         | 1380.6        |
| CAST NET      | 2647.2        | 1228.2        | 1569.2        | 806.9         | 985.1         |
| GILL NET      | 517.3         | 774.5         | 1589.2        | 2192.0        | 395.3         |
| SURROUND      | 3541.8        | 1961.5        | 3817.8        | 1855.6        | 3483.1        |
| SPEAR-SN      | 3209.1        | 1775.4        | 103.4         | 3794.4        | 4534.1        |
| SPEAR-SC      | 51.2          | 523.2         | 212.5         | 0.0           | 0.0           |
| HOOKS & GAFF  | 449.0         | 103.5         | 261.4         | 971.4         | 0.0           |
| DRAG NET      | 57.6          | 16.5          | 56.4          | 123.6         | 268.6         |
| OTHER         | <u>7732.9</u> | <u>468.1</u>  | <u>5578.6</u> | <u>1439.3</u> | <u>0000.0</u> |
| TOTAL         | 19469.8       | 7238.7        | 13471.6       | 11354.3       | 11046.8       |

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SN-spear fishing using snorkel equipment.

SC-spear fishing using SCUBA equipment.

Table 3. Person-Hours by Method for Tumon Bay FY '83 to FY '87.

| <u>METHOD</u> | <u>FY' 83</u> | <u>FY' 84</u> | <u>FY' 85</u> | <u>FY' 86</u> | <u>FY' 87</u> |
|---------------|---------------|---------------|---------------|---------------|---------------|
| HOOK & LINE   | 6692.4        | 5127.5        | 4750.0        | 4213.9        | 4361.6        |
| CAST NET      | 4577.4        | 2655.9        | 4702.3        | 2791.3        | 2451.9        |
| GILL NET      | 4698.2        | 2577.1        | 5438.0        | 2508.5        | 2296.0        |
| SURROUND      | 6246.6        | 3135.0        | 4487.7        | 3704.9        | 3938.4        |
| SPEAR-SN      | 1399.3        | 1748.9        | 243.8         | 2860.3        | 2349.3        |
| SPEAR-SC      | 34.1          | 31.5          | 208.4         | 0.0           | 0.0           |
| HOOKS & GAFF  | 1615.3        | 215.7         | 520.6         | 1843.8        | 0.0           |
| DRAG NET      | 72.1          | 16.5          | 144.0         | 202.6         | 342.9         |
| OTHER         | <u>7094.4</u> | <u>298.2</u>  | <u>4042.4</u> | <u>464.3</u>  | <u>0.0</u>    |
| TOTAL         | 32429.8       | 15806.3       | 24537.3       | 18589.6       | 15740.1       |

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SN-spear fishing using snorkel equipment.

SC-spear fishing using SCUBA equipment.

Table 4. Gear-Hours by Method for Tumon Bay FY '83 to FY '87.

| <u>METHOD</u> | <u>FY' 83</u> | <u>FY' 84</u> | <u>FY' 85</u> | <u>FY' 86</u> | <u>FY' 87</u> |
|---------------|---------------|---------------|---------------|---------------|---------------|
| HOOK & LINE   | 5788.5        | 5167.0        | 1759.0        | 1212.2        | 1488.7        |
| CAST NET      | 3598.5        | 2242.9        | 1470.6        | 1041.7        | 769.5         |
| GILL NET      | 2608.3        | 1148.0        | 576.6         | 493.0         | 278.7         |
| SURROUND      | 723.8         | 480.8         | 114.6         | 95.5          | 216.9         |
| SPEAR-SN      | 1375.3        | 1748.9        | 198.8         | 322.7         | 253.2         |
| SPEAR-SC      | 34.1          | 31.5          | 59.4          | 0.0           | 0.0           |
| HOOKS & GAFF  | 1548.3        | 215.7         | 212.6         | 433.9         | 0.0           |
| DRAG NET      | 72.1          | 16.5          | 19.5          | 18.6          | 21.2          |
| OTHER         | <u>7094.4</u> | <u>298.2</u>  | <u>757.0</u>  | <u>145.1</u>  | <u>0.0</u>    |
| TOTAL         | 22843.3       | 11349.5       | 5168.0        | 3762.8        | 3028.2        |

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SN-spear fishing using snorkel equipment.

SC-spear fishing using SCUBA equipment



## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** FW-2R-26

**SUB-PROJECT NO.:** F

**STUDY NO.:** F-1

**JOB NO.:** 13

**JOB TITLE:** Forecasting Abundance of Recreational Fishery Species in Guam through the Analysis of Oceanographic Patterns.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

The fluctuations of important recreational fish may be determined by measurable changes in oceanographic characteristics. By measuring these changes, it could be possible to forecast the size and length of the seasonal migrations.

### **BACKGROUND**

The most important recreational fishery species of Guam are migratory pelagic species, including skipjack and yellowfin tuna, mahi mahi, wahoo and blue marlin. These species occur during rather predictable "seasons" (e. g., mahi mahi season is from January to April; blue marlin season from June to October; wahoo season is from November to December), but their abundance in any particular year is quite unpredictable (mahimahi, for instance, may comprise anywhere from 10 to 40% of the total Guam trolling catch in a given year).

Fluctuations in the abundance of migratory pelagic species around one island area may be caused in two different ways (or by a combination of the two): changes in the numerical abundance of the fishes in the stock, or, changes in the migratory patterns of the fishes which may bring them closer to or farther from the island. In either case, these fluctuations may be correlated to variations in the oceanographic characteristics of the water the fish live in. The National Marine Fisheries Service (NMFS) Honolulu Laboratory has had success in predicting the abundance of skipjack tuna in the waters around Hawaii by relating their abundance to thermal characteristics of adjacent waters (Boggs, 1988).

### **OBJECTIVES**

To develop a means of predicting variations in the abundance of offshore recreational fish species by relating these fluctuations to variations in the oceanographic conditions around Guam.

## **RESULTS**

A literature search has been conducted and provides a basic knowledge of ideas and theories of the influence of oceanographic factors on the migratory patterns of fish. Bathythermograph data for the area 0°-20°N and 130°E-180°E has been acquired and is being analyzed by Dr. Steven Amesbury of the University of Guam Marine Laboratory.

## **RECOMMENDATION**

The ability of forecasting the abundance of recreational fishery species would be of great value in managing these species. DAWR therefore recommends that this project be continued.

## **LITERATURE CITED**

Boggs, C. 1988. Forecasting Skipjack Tuna Availability in Hawaii. Tuna Newsletter NOAA, 91:5-7.

Report prepared by: Timothy S. Sherwood

**GUAM FISHERIES DEVELOPMENT**  
**Project F-2-D**  
**Federal Aid in Sport Fish Restoration Act**





## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** F-2-D-6  
**SUB-PROJECT NO.:** FD 2

**JOB TITLE:** Construction of Fish Aggregation Devices and Development of a Shallow Water Mooring Program.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

The projected deployment of fish aggregation devices (FADs) anticipated for FY '89, was delayed due to difficulties with the deployment vessel (repairs on the Guahan I) and with delivery of the Division boat. The 20-foot boat was received and returned to the dealer for installation of wiring, outboard motor mount, etc. After initial use, the boat was again returned for service on 140 Hp Johnson Outboard and repair of non-functioning gauges. Neither the work on the Division boat nor the repairs on the Guahan I (by the Port Authority) were completed during FY '89. Mooring systems, received in FY '88, were checked for proper splicing, correct length, proper hardware, and corrected as needed. A ten foot section, one-third of the distance from the bottom of the polypropylene mooring line, was wrapped with hot pink fluorescent surveyors tape (to be used as a visual indicator of distance during deployment procedure). Sites for deployment were modified and approved by the Navy and Army Corps of Engineers (Table 1 and Figure 1). These sites were originally selected in 1979 and were modified (based on information on depth soundings, currents and fishing statistics) to enhance longevity and performance.

The popularity of water related activities has caused an increase in damage to the coral reefs due to the setting of anchors. One way that this damage has been reduced in other parts of the world is by the installation of mooring buoys. During FY '89, mooring design and site selection for shallow water mooring were initiated.

### **FISHERIES AGGREGATING DEVICES**

#### **BACKGROUND**

A variety of FAD (Fish Aggregation Device) designs have been used by many countries, but the basic design consists of a floating object (buoy or raft) attached to a mooring line and held in place by an anchor system. For centuries, early forms of FADs, like cork rafts in Malta and bamboo rafts in Japan and the Philippines, have been used to attract pelagic (open water) fish. Due to the apparent effectiveness of these floating objects in the Pacific region, the National Marine Fisheries Service (NMFS) began a pilot program in 1977 around Hawaii to determine if a FAD would attract, aggregate and hold pelagic fish in the area, ultimately increasing the catch of fishermen. Because of the great success of this program, twenty-three Pacific basin countries, including the Territory of Guam, had deployed over six hundred FADs by 1983.

Early FADs have had very short life spans. From 1977 to 1984, the life of the FADs ranged from several minutes (lost during deployment) to twenty-two months. Reasons most often cited for losses of these systems, in decreasing order of importance, were hardware or mooring line failure, severe storm activity, man bite (propeller or anchor damage), fish bite, unsuitable site selection and other unidentifiable reasons. Considerable improvements have been made to the design and maintenance of the FADs in order to decrease the premature loss of the system. The working life expectancy of the FAD is now two years compared to an average of nine (9) months for the initial design.

Construction of the FADs in Guam began in 1979, initially under funding from the Pacific Tuna Development Foundation, and was later continued as part of the Dingell-Johnson Fisheries Development Program. By the end of FY '83, the 10 FAD systems deployed had been lost, primarily due to problems involving mooring system design and materials. The FADs had proved successful throughout the Pacific as well as in Guam. Reactivation of the program was seen in FY '87. Information provided by the South Pacific Commission (SPC) regarding design improvements on the mooring systems and deployment procedures have been incorporated to increase the longevity by decreasing premature loss of the FAD system.

## **OBJECTIVE**

To enhance Guam's heavily utilized nearshore, leeward fishing grounds through establishment of a system of FADs.

## **PROCEDURE**

### **FAD Design**

Little change has been made with the FAD design of FY '89 over that envisioned in FY '87. Each FAD consists of a 400 pound surplus Coast Guard buoy which has been refinished and equipped with welded steps and a mount for an eight-cell McDermott Navigational light. These lights are projected to last up to a year before battery failure. In addition, these lights have a back-up bulb system that automatically activates to a two bulb flash when the primary bulb fails, minimizing maintenance and safety hazards. Each buoy is attached to an inverse catenary loop mooring system. This mooring design requires 300 fathom depths or greater.

The mooring design (Figure 2) is as follows: a 400 lb. buoy attached to the following mooring components connected in series: 1 1/4 " anchor shackle, 3/4 " eye and eye swivel, 3/4" safety shackle (SS), 50 feet of 3/4" chain, 3/4 " SS, 3/4" eye and eye swivel and a 3/4" SS. The last SS is connected to a predetermined amount of 12 strand plaited 5/8" nylon rope by a nylite thimble. These thimbles have proven very effective on other FAD systems. The 12 strand nylon rope is machine spliced into a 12 strand plaited polypropylene rope. The polypropylene completes the catenary loop and descends to the anchor system. The end of the polypropylene is joined to 100 ft. of 3/4" chain with the same mooring components used to join the upper chain and nylon, but in reverse order (thimble, SS, swivel, SS). The bottom of the chain is then connected to the first anchor block (2,000 lb. rebar reinforced concrete block) with a 3/4" SS and is then connected to the second anchor block by 15 ft. of 3/4" chain and a 3/4" SS. The calculations for the lengths of nylon and polypropylene vary for each FAD (Table 2), depending on the amount of hardware to be lifted by the polypropylene, the current, depth and substrate conditions (Boy and Smith; 1984). Table 3 lists the updated cost of the FAD materials and deployment.

### **Deployment Procedures**

Some changes have been made to the planned deployment procedure described in FY '88 annual report. The Heavy Equipment Section of Guam Community College has removed rebar spikes from the anchor blocks and has been contracted to transport all gear to the Port for the

deployment. Three vessels will be required during each deployment. The Port Authority of Guam's landing craft, the Guahan I, has been contracted to deploy the buoys, moorings, and anchors. The loading of gear onto the Guahan I has been contracted through the Port Authority Operations Section. The Island Girl, a private boat with depth sounding equipment, has performed the site surveys and has been chartered to find and mark the sites during each deployment. In addition, the Division's boat will be used to tow the buoy away from the deployment vessel.

The entire FAD system consisting of the buoy, assembled mooring system, and anchor system will be loaded on board the deployment vessel and connected prior to departure. During loading, the FAD components will be positioned aboard the deployment vessel (Figure 3) to allow easy deployment and maximize safety. The anchor system (concrete blocks, chain and connecting hardware) will be assembled but not connected to the mooring line until the mooring line has been faked out. The 2 one-ton anchors will be placed on the gunwale in the recessed area of the bulwark. The buoy will be secured on the starboard gunwale, near the stern, where it will be deployed first. The crate containing the mooring lines will be placed against the starboard bow side of the wheelhouse (a section of scrap chain will be secured to the starboard side of the bulwark with a quick release mechanism attached to control the release of the chain from a safe distance). The mooring system has been prepacked with the polypropylene on bottom and the nylon on top. Both the nylon and the polypropylene ends have been taken out to facilitate easier connection with appropriate materials. Once all equipment is readied, the vessel will be prepared to leave port.

Upon reaching the general vicinity of the deployment site, the chartered vessel will identify the actual FAD placement site. Once the anchor chain has been connected to the nylite thimble on the polypropylene rope, the deployment vessel will move down wind of the deployment site along with the Division's boat. The buoy (without the navigational lights installed) will be deployed first. The Division vessel will stay with the buoy until all the mooring line is deployed. Prior to dropping the anchors, the Division boat will be informed by radio to release the buoy. For reasons of safety, no individual will be anywhere between the mooring line and the gunwale at any time. The entire system will be towed upwind, until one third of the mooring line (flagged with surveyors tape) is past the deployment site. The Division boat will pull the line straight, but not taut, to act as a parachute for the anchors. This should help prevent the anchor blocks from breaking upon impact with the bottom and aid in predicting where the anchors will hit bottom. The quick release system will be used to deploy the bottom chain and anchors and will allow the vessel crew to release dangerous equipment from a safe distance. Once the quick release mechanism is triggered, the anchor system will begin deploying. The drag of the mooring line and the weight of the chain should be enough to pull the anchors overboard but the use of a lever may be needed from inside the bulwark to assist in anchor deployment. All vessels will stay in radio contact throughout the entire deployment process and will remain clear of the system once the anchors have been deployed. When the buoy stops moving, the anchors should have reached the bottom. Once the movement has stopped, the navigational light will be installed and an accurate site location recorded by the chartered vessel.

## RESULTS

All preparations for deployment (see Project Status summary) were completed in September 1989. A deployment date was chosen for September 26 but was rescheduled for October 13, 1989 (early FY '90) because of unexpected repairs on the deployment vessel, the Guahan I.

### Project Status

During FY '87:

- a) Fourteen (14) surplus Coast Guard buoys were refinished with welded light mounts and 14 one-ton reinforced cement anchors were constructed.



During FY '88:

- a) Sixteen eight cell McDermott navigational lights were purchased and delivered.
- b) A purchase order for a 20 foot-boat was approved.
- c) Quotations from three private boat owners for sounding were received.
- d) Preliminary arrangements were made with the Port Authority of Guam to use the landing craft, Guahan I, for deployment of FADs.
- e) Five pre-assembled mooring systems plus materials for 5 additional systems were purchased from American Rigging & Supply.

During FY '89:

- a) Mooring systems were received from American Rigging & Supply.
- b) A 20-foot boat was received from Marianas Boat and Supply and was returned for installation of gauges and trailer lights.
- c) Island Girl Charters received the contract for site surveys (completed in August), and for depth contours and position mapping of FADs to be done immediately following deployment.
- d) A new biologist was hired to take over FADs project.
- e) Work request submitted to Port Authority of Guam for use of Guahan I (vessel, crew and fuel).
- f) Rebar spikes on anchors were removed by Guam Community College Heavy Equipment section and arrangements were made for transport of equipment to the Port prior to deployment.
- g) Additional cleats, radio mount, radio antenna and miscellaneous gear were installed by Division staff and the boat was registered.
- h) The Division boat was returned to the dealer to correct problems discovered during initial operation and for installation of a new mount for the auxiliary outboard motor.
- i) Additional gear (i.e., 1 1/4 inch anchor shackles) was purchased for the buoy system to enable attachment of buoy to mooring lines, mooring lines were inspected for proper splicing and length, and fluorescent surveyors tape was used to mark the polypropylene line (visual marker during deployment).
- j) Permits were amended for new positions for deployment sites and were approved by the Coast Guard.
- k) McDermott navigational light systems were wired for connection with 6 volt batteries and checked for operation.
- l) Sampling gear was purchased for fishing around FADs for analyzing effectiveness of attraction of fish.

## RECOMMENDATION

- a) Deploy 5 FADs as soon as conditions allow.
- b) Monitor fishing activity of these sites through existing creel surveys.
- c) Develop a sampling regime to compare fishing in FAD versus non-FAD areas.
- d) Make monthly inspections of upper moorings, make repairs, and keep records of maintenance as well as aggregated fauna.
- e) Keep records of all buoys lost, if any, and determine reason, if possible, for loss.
- f) Replace any buoys lost as soon as possible as long as loss is not due to problems with site selection (i.e., current, depth, etc.)
- g) Select additional sites for future deployment.
- h) Deploy more buoys if mooring systems appear adequate to endure a 2-year period and, if results from sampling and creel surveys demonstrate success.



## SHALLOW WATER MOORINGS

### BACKGROUND

Many boaters have a favorite spot where they anchor to dive or fish. The DAWR has received many reports of damage to the reef caused by anchors. It has been estimated that over 30% of anchor settings on coral reefs cause damage (Halas 1985). Some boaters place "home-made" moorings to avoid the problem of anchors getting fouled in coral. "Home-made" moorings are constructed out of concrete or automobile parts and a buoy connected by chain. These moorings are then haphazardly placed in the general area of heavy coral growth. Storm swells move these moorings around and thereby destroy large amounts of coral. In addition to the storm movement, slack in the chain during low tide causes damage in the immediate area of the mooring. Due to the slow growth of corals, it takes years to repair the damage. This damage not only effects the coral in the immediate area but it also decreases available habitat for other marine organisms.

Halas (1985) studied this problem in the Florida Keys and designed a mooring buoy program that prevents excessive anchor damage to reefs. Halas' mooring design incorporates an 18 inch deep hole that is drilled into the reef. An eyebolt is cemented into this hole and a mooring line attached to it. The mooring line runs through the center of the buoy and the end of this line is used as a pick up line by boaters. Halas placed some of the moorings in areas that previously were not utilized. By doing this, Halas has attracted people away from the popular areas to areas that were previously underutilized. In conjunction with the mooring buoy program, Halas has printed handouts that describe the areas around each mooring. This program has become such a great success that it is now being expanded beyond the boundaries of the park and has been adopted by islands in the Caribbean and Hawaii. The Halas method will be applied in areas with hard substrate. The anchor systems proposed for sandy areas will utilize auger type anchors that were originally designed to cork-screw into the ground to secure guy lines from telephone poles.

### OBJECTIVES

To establish a shallow water mooring buoy program to minimize coral damage in common boat anchoring areas and to enhance fishing access in area with anchoring difficulties.

### RESULTS

A literature search has been conducted and provides a basic knowledge of shallow water mooring systems which are currently being used in other parts of the world. Trial auger type anchors commonly used to secure guy wires for telephone poles were donated to the Division by the Hawaii Sea Grant Program.

### RECOMMENDATIONS

1. Purchase required mooring materials.
2. Select mooring sites
3. Develop installation and maintenance methodologies.
4. Implement Government review and comply with permitting requirements.
5. Develop a time frame for installation.

## LITERATURE CITED

- Boy, R. L. and B. R. Smith. 1984. Design improvements to fish aggregation device (FAD) mooring systems in general use in Pacific island countries. South Pacific Commission Handbook no. 24. Noumea, New Caledonia, pp. 77.
- Halas, J. C. 1985. In Proc. 5<sup>th</sup> Int. Coral Reef Congress, Tahiti, Volume 4, May 27-June 1, 1985, pp. 237-242

Report prepared by: Rebecca Hensley and Timothy S. Sherwood

**Table 1.** Original and revised (Sept, 1989) U.S. Navy and U.S. Coast Guard permit approved FAD deployment sites.

| SITE             |              | DEPTH |  | LOCATION   |            |
|------------------|--------------|-------|--|------------|------------|
| Number(Name)     | Fathoms/Feet |       |  | Original   | Revised    |
| 1 (Facpi)        | 570/3,420    |       |  | 13°20.2'N  | 13°20.5'N  |
|                  |              |       |  | 144°36.4'E | 144°36.5'E |
| 2 (Haputo)       | 400/2,400    |       |  | 13°37.1'N  | 13°35.5'N  |
|                  |              |       |  | 144°46.5'E | 144°45.5'E |
| 3 (Cocos)        | 600/3,600    |       |  | 13°14.0'N  | 13°14.5'N  |
|                  |              |       |  | 144°37.4'E | 144°36.5'E |
| 4 (Ritidian)     | 500/3,000    |       |  | 13°43.1'N  | 13°42.5'N  |
|                  |              |       |  | 144°53.9'E | 144°46.5'E |
| 5 (Hospital Pt.) | 500/3,000    |       |  | 13°32.1'N  | 13°31.7'N  |
|                  |              |       |  | 144°42.7'E | 144°43.5'E |

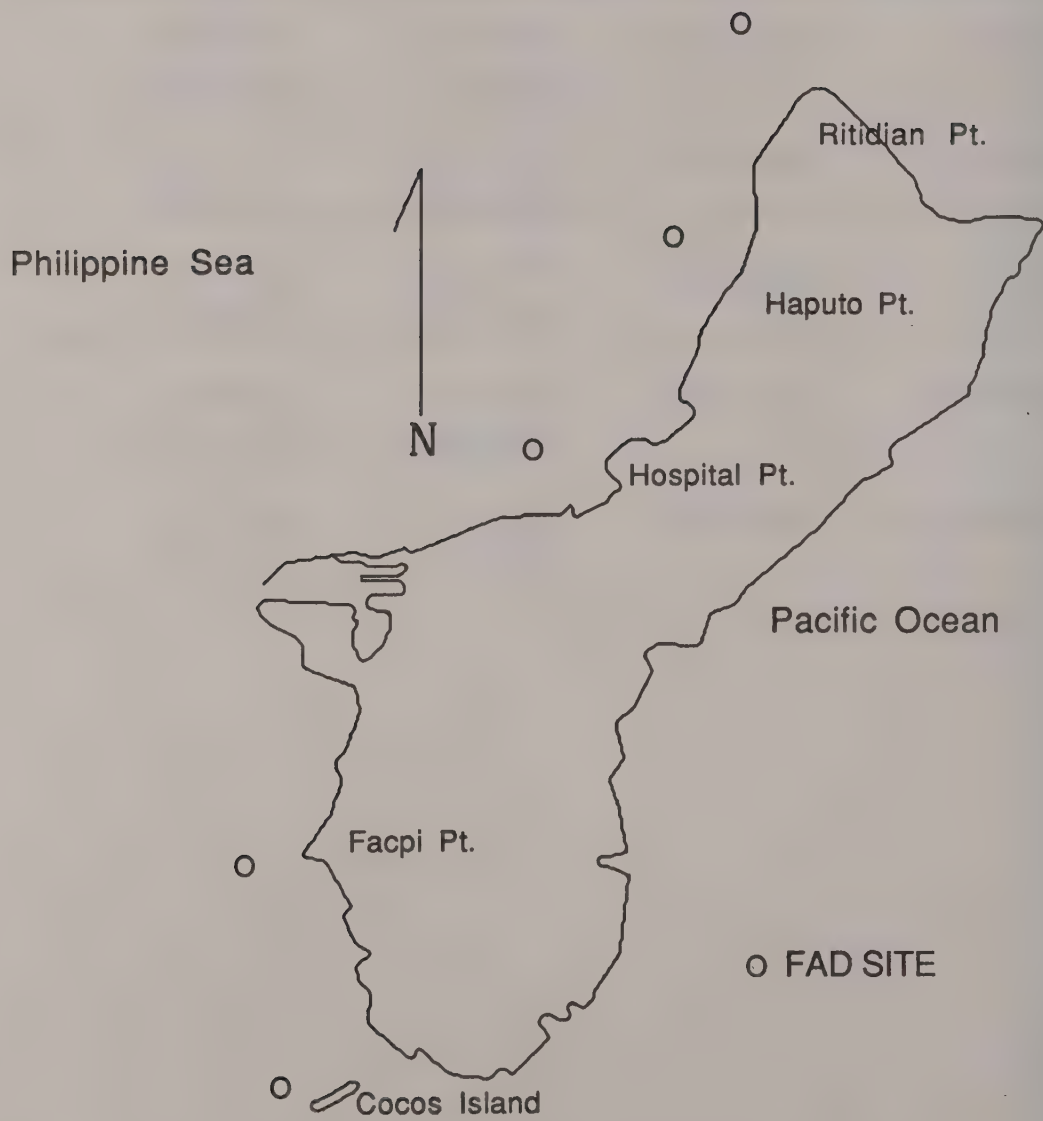


Figure 1. Proposed FAD sites for 1989



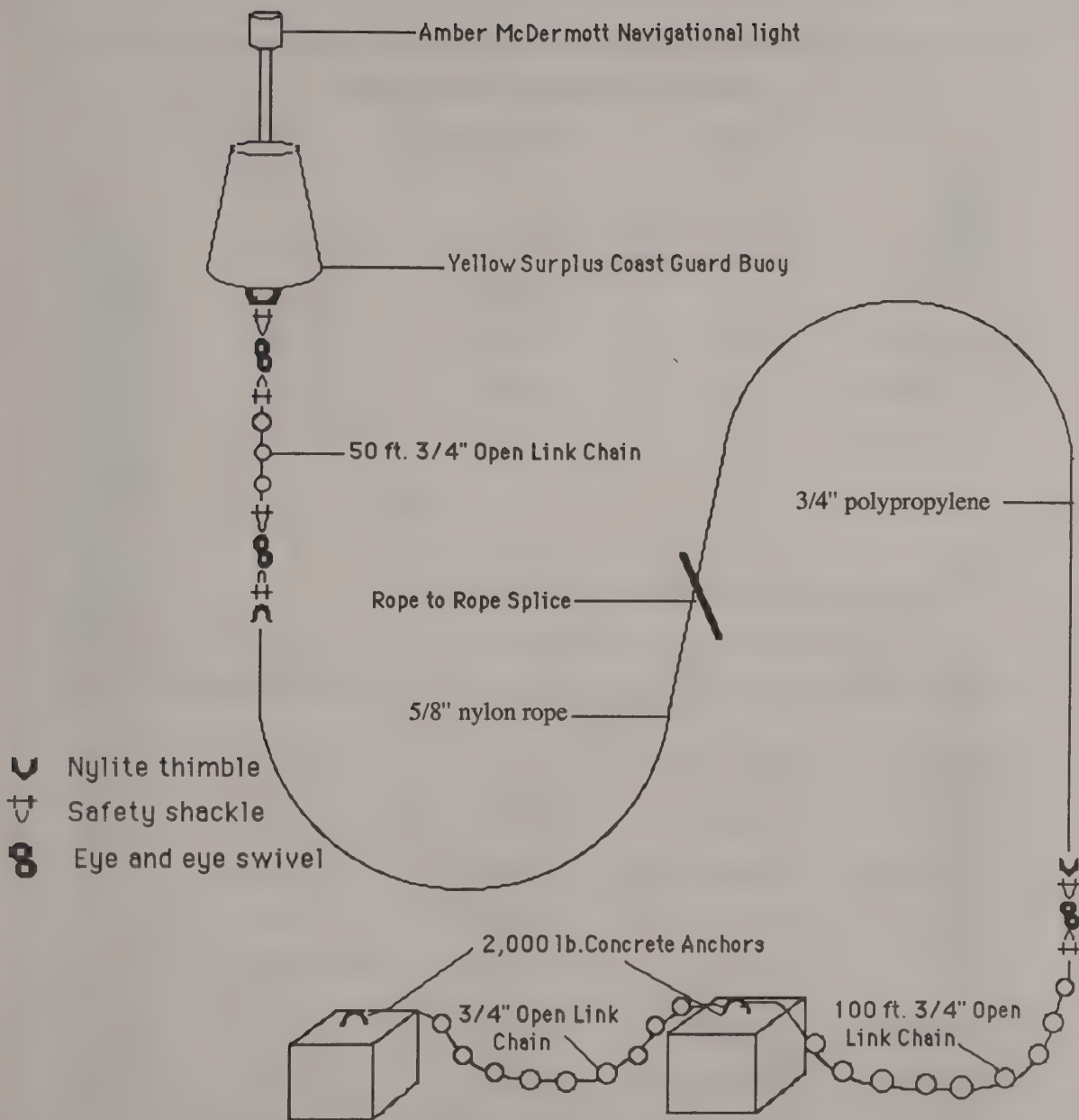


Figure 2. Deepwater (800 Fathom) inverse catenary FAD design

**Table 2.** Length of mooring system with calculated nylon and polypropylene lengths.

| <b>MOORING SYSTEM LENGTHS (ft)</b> |              |                      |                     |
|------------------------------------|--------------|----------------------|---------------------|
| <u>Site</u>                        | <u>Nylon</u> | <u>Polypropylene</u> | <u>Total Length</u> |
| 1 (Facpi)                          | 1,352        | 2,812                | 4,164               |
| 2 (Haputo)                         | 875          | 1,965                | 2,840               |
| 3 (Cocos)                          | 1,348        | 2,992                | 4,340               |
| 4 (Ritidian)                       | 1,214        | 2,426                | 3,640               |
| 5 (Hospital Point)                 | 1,214        | 2,226                | 3,640               |

**Table 3.** Cost list for FAD materials and deployment

| <b>QUANTITY</b>     | <b>ITEM</b>       | <b>COST (\$)</b> | <b>COST per FAD (\$)</b> |
|---------------------|-------------------|------------------|--------------------------|
| 14 (2000 lb.)       | Cement blocks     | 4000             | 571.43                   |
| 14(Tear drop)       | Buoys             | 7000             | 500.00                   |
| 10(5 sets of 2)     | Mooring systems   | 26,860.00        | 5,372.00                 |
| 10 systems          | shipping costs    | 2,564.64         | 171.29                   |
| 16                  | buoy lights       | 2,740.66         | 171.29                   |
| 5 (deployment)      | vessel/barge      | 8,292.20*        | 1,658.24                 |
| 5 (locations)       | depth sounding    | 15,000           | 3,000.00                 |
| 5 systems           | transport to Port | 32 per hour**    | 6.40 per hour            |
| 5 (anchor shackles) | 2 " gap for buoy  | 175.25           | 35.05                    |

\* Money encumbered but not released

\*\*Money not encumbered but cost confirmed

## FAD Deployment Barge

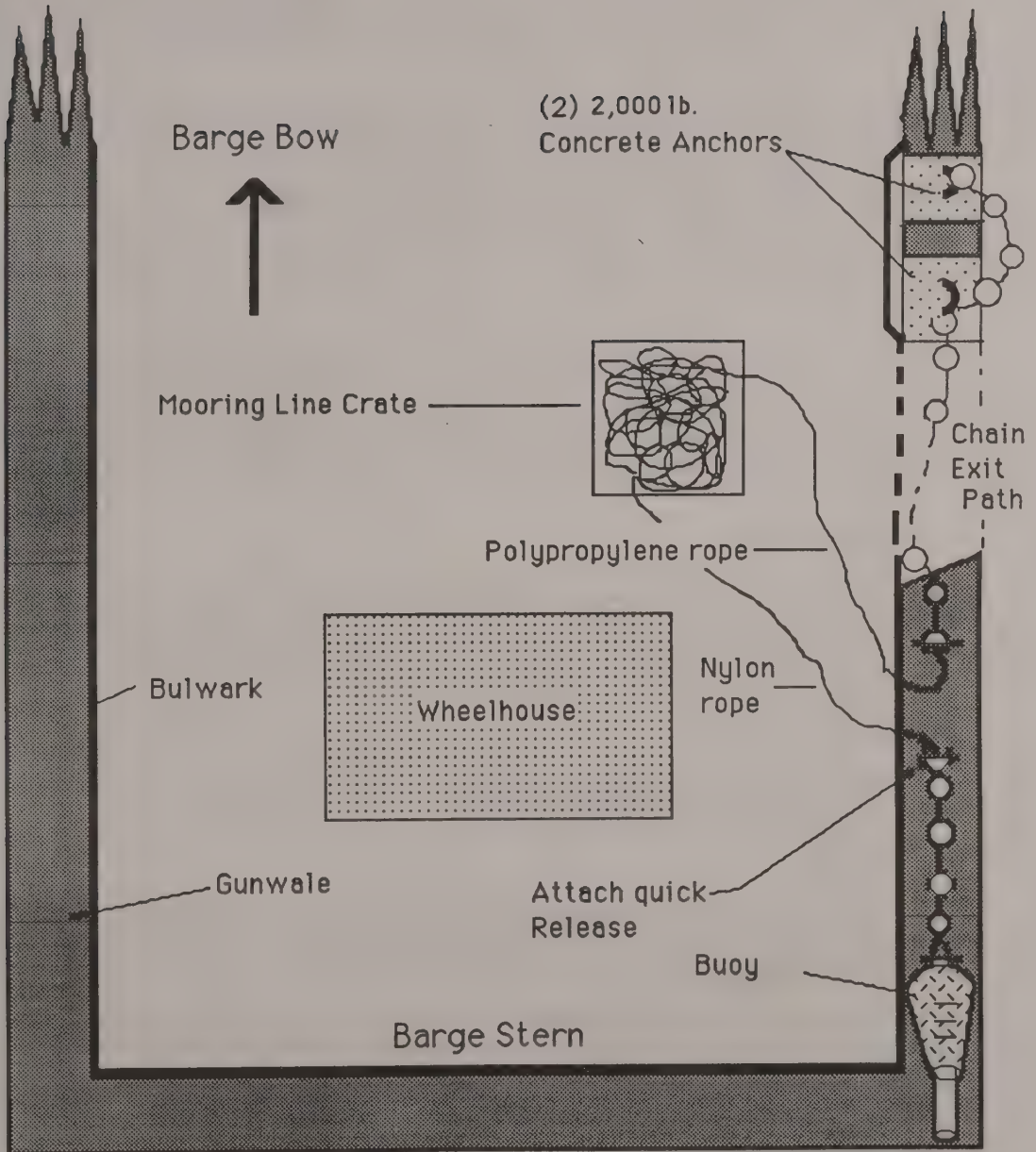


Figure 3. Equipment layout on FAD deployment vessel, the Guahan I

## **PROJECT SEGMENT DEVELOPMENT PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** F-2-D-7  
**SUB-PROJECT NO.:** FD 2

**JOB TITLE:** Construction of Boating Access Facilities.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

During FY '89, plans for the construction of a replacement pier in Merizo were finalized and the construction company International Bridge and Construction, was retained as of September 26, 1989. A total of \$382,209.80 has been obligated to this project to date. No date for the beginning of construction has been announced. The design plans for two boat ramp facilities were donated to the Division of Aquatic and Wildlife Resources (DAWR) by the Department of Commerce.

### **BACKGROUND**

As initially proposed, the objective of the Merizo Pier project was to repair and extend the existing pier. An inspection of the existing pier revealed that the structure had deteriorated to the extent that renovation was impractical. The scope of the project was revised to the design and construction of a new pier during FY '88.

### **OBJECTIVE**

To increase boating accessibility to fishing grounds through the creation of safe, strategically located boat launching facilities.

### **RESULTS**

During FY '89, the planning phase for this project was completed and a construction company (International Bridge Corporation) was contracted to demolish the old pier and build the new one. Construction is slated to begin during FY '90.

DAWR received from the Government of Guam Department of Commerce (DOC) plans for the construction of two boat ramps. One is designed for Inarajan and the second for the Harbor of Refuge in Piti. These were designed for DOC by Tropic Architects. DOC no longer has funding to proceed with these projects and DAWR is considering these plans for funding under this project.

### **RECOMMENDATIONS**

The Merizo pier project should be carried through to completion during FY '90. Construction time is estimated to be less than six months from the onset of activity.



Consideration should be given to following the Merizo Pier construction with renovation or replacement of the existing Merizo boat ramp, which is located adjacent to the pier. Planning and design work for this proposed phase of the Merizo project has not yet been initiated.

The boat ramp plans acquired from DOC for ramps in Inarajan and at the Harbor of Refuge need to be reviewed for design applicability and cost of construction before incorporation as a project job.

An assessment should be made of the need for development and/or enhancement of other existing facilities as well as identification of as yet unutilized boating access locations. Enhancement projects might include placement or maintenance of channel markers or buoys, onshore lighting, navigational aids and parking lot improvement. Identification of new sites might be facilitated through analysis of demographic distribution of boaters in relation to existing facilities to determine where a need exists for more conveniently located ramps and piers and a review of the reefs and bays of Guam to identify geographic locations with natural features suitable for development as boating facilities.

Report Prepared by: Gretchen R. Grimm

## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** F-2-D-9  
**SUB-PROJECT NO.:** FD

**JOB TITLE:** Inshore Fishing Access Facilities.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

During FY '89, initial planning and fishing platform design were explored to provide facilities for inshore fishing access. Thirty-six areas around Guam have been field surveyed for fishing platform sites. A small scale model of the platform was designed to demonstrate our basic concept. Because of salt water corrosion on metal, fiberglass has been selected as the preferred construction material. Four architectural engineering firms were contacted regarding fiberglass construction. After the preliminary fiberglass construction design has been completed, the approval of selected sites will be sought. Once permitting for site construction has been completed, the project will be put out on bid.

### **BACKGROUND**

Historically, reef flat fishing has been a way of life for Chamorros. Many local people still fish Guam's shallow waters both for food and recreation. Every year, a number of drownings and near drownings take place due to the hazards associated with fishing. To provide a safer environment and increase hook and line sportfishing opportunities, reef flat fishing platforms have been proposed for Guam.

Traditionally, local fishermen have constructed platforms near sandy areas inside bays. Typically, platforms have been fabricated with "tangan-tangan" poles with a floor of split bamboo lashed to the frame above high tide levels. Frequently, the platforms have two levels to their construction. Normally, they have been used during periods of rising or high tides. During these times, many of the larger fish living along the reef margin enter the inshore areas to feed and leave with the receding tide.

The concept of fishing platforms can be transferred to areas with hard substrata to increase fishing opportunities. Presently, there are favorite inshore and reef fishing areas where people fish because of the shoreline topography or water circulation patterns. Fishing platforms should be located in areas where people cannot fish regularly now due to the existing conditions, or in areas that pose a safety problem for people who want to fish. Permanent fishing platforms built to withstand the natural conditions of the area would allow usage in areas that are typically unsafe.

### **OBJECTIVE**

To provide a safe means of enhancing the available inshore resources through the construction of shoreline fishing access facilities.

## PROCEDURE

The Division of Aquatic and Wildlife Resources (DAWR) has been actively evaluating and surveying sites using five established criteria for locating fishing platforms: (1) The sites should have a solid substrata like limestone for anchoring the platform with no coral present; (2) The site should be accessible so that people can reach the platforms easily to fish; (3) The sites should be close to deep water areas with known fishing potential; (4) The platforms should be placed in areas that would cause minimal environmental damage to the existing substrata; and (5) Location of platforms should take advantage of unique features like a peninsula, coral heads, reef cut, channel or bays where fish may congregate.

### Fishing Platform Design

The design of a viable fishing platform has been a challenge. Many designs have been sketched and merits of each design evaluated. The fishing platform would need to withstand constant wave activity, salt water corrosion, remain dry on top during daily tidal fluctuations and allow enough area for the people fishing to move around for casting. The platform should be designed to use a minimal amount of substrata area, be easy to maintain, and provide an increased margin of safety while fishing.

We were initially involved in locating architectural engineering firms skilled and trained in the design of fishing platforms. Thirteen consulting engineering firms were contacted and a visit made to each of their offices. A platform sketch was done by a local consulting engineer with considerable experience in building off-shore oil drilling platforms in Alaska. Our own sketch followed with a design being selected for the platform. The basic plan consisted of a platform (6 ft. X 6 ft.) with railing and a ladder about 6 ft. above the limestone base (Figure 1). A model was constructed of the proposed platform design.

A fair amount of time has been spent identifying the materials that could possibly be used in the construction of the fishing platforms. The first basic idea was to build the platforms with cement. It was initially proposed that cement be used. However, because of environmental concerns relative to the amount of area needed for foundations and the logistics of doing extensive cement construction at the reef margin, the idea has not been pursued. Galvanized steel was also considered as a building material. The sketch drawn by the local consulting engineers would have the platform itself constructed of metal hot dipped in zinc with piles made of concrete or metal. Plans using galvanized steel have been completed by a local fencing company. The galvanized steel could be further painted with zinc and epoxy paints. A sealant would need to prevent dulling of the epoxy paint due to the intensity of ultra-violet rays. There is a variety of other paints that can be used over metal to prevent salt water corrosion. Whatever the case, the metal, complete with surface treatment, should be able to withstand salt water corrosion for between five to ten years.

The most obvious alternative choice seemed to be fiberglass. Most off-shore oil rigs have been converting to fiberglass due to the corrosion of painted metal piles on the rigs. Three fiberglass companies on Guam are interested in the project. In addition, a major fiberglass manufacturer in the mainland has been contacted and may be able to assist us.

The overhang type platforms have not been discussed in this Report. Although preliminary sketches have been made of how they could be designed, we have not spent much time implementing the overhang design because the other design has received a higher priority. A number of areas are presently being considered for overhang platforms and will be surveyed when the conditions are ideal.



## RESULTS

To date, thirty-six areas have been evaluated for fishing platforms. Twelve areas are actively being considered for fishing platforms around Guam: (1) Ajayan Bay, (2) Togcha Bay, (3) Piti Bay (Tepungan Channel), (4) Asan Bay, (5) Inarajan Bay, (6) Mana Bay, (7) Asanite Bay, (8) Asagado Bay, (9) Sumay Bay, (10) Agafayan Bay, (11) Pauliluc Bay, and (12) Pago Bay. The Togcha, Asan, Mana, Asgadao, Asanite, and Sumay Bays are all cuts in the reef margins that allow the water to drain or flush the reef flats during tidal fluctuations. Ajayan, Inarajan, Agafayan, Pauliluc, and Pago Bays are all major bays with deep water and rivers flowing into them. The Tepungan Channel in Piti Bay is a dredged channel for the Piti Power Plant on Cabras Island. Other areas have been identified and will be examined when the tidal and wave conditions allow it.

The design of a fishing platform constructed of fiberglass has proceeded slowly. One company has submitted plans for a fiberglass platform, but, has not submitted their proposal on how it should be anchored. An engineer would like to test new structural materials to determine some values for their structural computer program in Korea to come up with an idea of how the platform should be designed. A local fiberglass company has expressed an interest in the fishing platform project, but has had to concentrate on a higher priority project. A major fiberglass company has also been contacted in California. We should soon have some plans for the fishing platforms and their anchoring systems.

## DISCUSSION

We have five established criteria for locating fishing platforms and all are still valid. The first criteria is that a solid substrata be present for anchoring the platform such as limestone with no coral present. Some of the sites have a solid limestone substrata. Others are honeycombed due to the wave activity in the area. At this time, it is not known whether the presence of honeycombed limestone will restrict the placement of a platform at a particular site. It will depend on the anchoring system designed for the platforms and the amount of honeycombed limestone below the surface.

There are other factors to be considered in the anchoring of a fishing platform in the substrata. The size of area needed has not been determined and may be an additional criterion to consider in building a fishing platform. Some of the sites have an uneven substrata with some being more uneven than others.

The second criteria deals with accessibility and the need for people to access the platforms easily to fish. There are some excellent sites however, many are far too remote and a value call will have to be made to determine whether sites are worth the walk. This can be particularly important if a person is carrying an array of fishing gear. Some access problems can be encountered, e.g., if a platform is placed in an area with private property adjacent to the shoreline. People wanting to fish would use the shoreline adjacent to the private property to reach the platform. The private landowners may object to platforms because it may affect their ocean view and bring the public to the shoreline. In areas where access to the shoreline may be a problem, land may need to be purchased. The other criteria are self explanatory and need further discussion at this time.

In addition, there are a number of constraints to constructing fishing platforms around Guam. Many prime sites are located in areas where the shoreline properties are owned by the military or by private owners. Public access across military land is frequently restricted. Private landowners in some cases, place "No Trespassing" signs where people normally have gained access to the shoreline. There are very restrictive local and federal laws pertaining to construction within the coastal zone and navigable waterways around



Guam and it is anticipated that significant time may be required to obtain the required permits. Although this may be a hindrance, there has been verbal support by most agencies for the construction of fishing platforms around Guam.

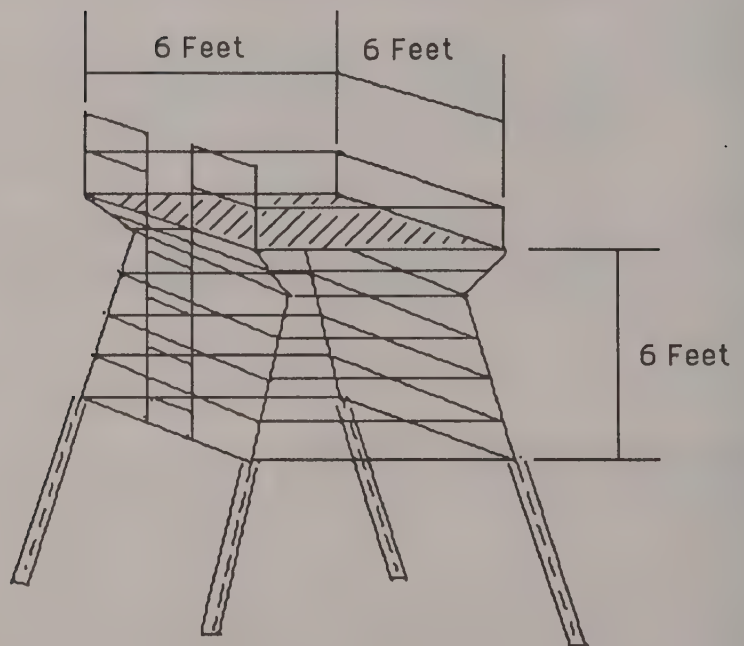
Another constraint is that the permanent fishing platform concept is a new application of a traditional idea. There has been no ready source of information and/or literature about how to design and/or construct fishing platforms using modern materials. Our ideas are original and have not been field tested in the Pacific region. The concept seems valid and our work may represent a model that other Micronesian fisheries managers may want to use to increase sport fishing opportunities along their shorelines.

## RECOMMENDATIONS

1. We recommend that this job vigorously pursue the construction of fishing platforms around Guam. In addition, federal program coordinators are encouraging the development of shoreline fishing structures to assist in providing safe access for people who want to fish without using a boat.
2. During the next fiscal year, we will have finalized plans for our shoreline fishing platform and anchoring system. The substrata at each site may need to be drilled and analyzed to determine whether or not the site would be feasible for the fishing platform anchoring system. The shoreline survey will continue to locate potential fishing platform sites. We would like to initiate the permit process to get site approvals and/or comments from the various Government of Guam agencies about our proposal to construct fishing platforms. Some planning can be initiated while the permit process is on-going to insure that the platforms are put out as soon as possible after the approvals are granted for the sites.

Report Prepared by: Wayne Kruckenberg

### Fishing Platform Design



**Figure 1.**

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

**STATE:** Territory of Guam

**JOB TITLE:** Giant Clam Transplantation

**PERIOD COVERED:** October 1, 1988 to September 30, 1989.

### SUMMARY

One hundred broodstock (5 year old) giant clams (*Tridacna derasa*) were obtained from the Micronesian Mariculture Demonstration Center (MMDC), Palau. Forty-eight of them were placed in unmarked sites within Apra Harbor and the remainder left at the Guam Aquaculture Training and Development Center (GATDC) at Fadian (herein referred to as the Fadian facility). Twelve clams were placed at each of four Apra Harbor sites, 6 each at 5 and 10 m depths, respectively. Two additional sites within the harbor were selected for additional clams to be placed in early FY '90.

### BACKGROUND

Species of giant clams (genus *Tridacna*) are an important traditional food as well as a potentially valuable export commodity for Asian food markets and the worldwide aquarium trade (Copeland and Lucas, 1988). During the past 3 decades, giant clam stocks on most coral reefs have become seriously depleted. Three species are native to Guam: *Tridacna maxima*, *T. squamosa*, and *Hippopus hippopus*. The largest species, *T. gigas* is known from Guam only on the basis of fossils, and apparently went extinct before the arrival of humans. *T. maxima* was once quite common on reef flats as well as clear-water reef slopes, but has become scarce or disappeared on most reef flats. *T. squamosa* and *H. hippopus* are quite rare, and generally occur in less accessible habitats.

All species of *Tridacna* and *Hippopus* are phototrophic, that is, they harbor single celled plants (zooxanthellae) that manufacture most if not all of the clam's nutritional requirements. The clams therefore require relatively shallow, clear water with good exposure to sunlight, but do not require supplemental feeding. When under about 6 to 10 inches valve width, they are prone to predation by certain fishes (primarily rays and large triggerfishes and puffers) and drilling parasitic gastropods. Larger clams and those of reproductive age (5+ years) are relatively immune to predation.

In recent years it has been demonstrated that giant clams may be effectively cultured and transplanted (Heslinga, et al., 1990). The species *Tridacna derasa*, second only to *T. gigas* in size, has proven to be the most feasible and fastest-growing as well as most readily available from a hatchery. It is well-adapted to lagoon environments which can be monitored more easily than exposed seaward reefs. It therefore has the best potential for becoming established as a fishery resource.

## OBJECTIVE

To introduce and establish the giant clam *Tridacna derasa* on the reefs of Guam.

## PROCEDURES

Site Selection: In order to have the greatest chance of success with the least effort in manpower, it was decided that mature clams of 5 years of age should be used. With the assistance of the Fadian facility, it was possible to import the clams from Belau and hold them in flow-through seawater holding tanks until they could be placed in the field.

There are no marine preserves on Guam and current regulations allow the taking of clams with valve lengths between 5.8 and 11.9 inches. Because the 5-year old clams imported fell within this range, it was unfeasible to effectively protect illegal sized clams from poachers. An area with the following characteristics therefore had to be found:

- accessible by small boat under most conditions
- deep enough for the clams to be difficult to see from the surface and inaccessible to walkers
- protected from rough water
- as close as possible to the clam's natural lagoon habitat, and free of pollution

Apra Harbor was selected as the best possible location for meeting these conditions. the following six sites spanning the length of the harbor were selected (Fig. 1): (1) Sasa Bay patch reef, (2) Sasa Bay entrance reef, (3) Jade Shoals (2 sites), and (4) Glass Breakwater on Calalan bank (2 sites). The innermost sites provide the protection of relatively turbid water, making the clams difficult to find, yet still meet their ecological requirements, while the outermost sites provide possibly more ideal conditions of clearer water, but are more vulnerable to poaching.

Processing and field placement: All clams were placed in holding tanks at the Fadian facility immediately upon arrival. On the day of placement in the wild, each clam was measured with a pair of large brass calipers and marked with an indelible marker, then wrapped in dampened newspapers in lots of 3 per styrofoam container. Placement in the field was accomplished within 3 hours. All clams were placed on rubble or sand patches between coral heads in groups of 6, each no further than 1 m from its nearest neighbor. A map of each site showing the exact placement and orientation of each clam as well as distinctive bottom features was prepared.

Monitoring: All sites are to be periodically monitored to observe the condition of the clams, remove parasitic gastropods, and take measurements for growth studies. Monitoring should be done on at least a semi-annual basis.

## RESULTS

All but one clam arrived in good condition. The unhealthy clam died within two days. Twenty-four clams were placed at the two Sasa Bay sites on Sept. 20 and 24. Others were placed at the Jade Shoals sites on Sept. 28. Twenty four more clams are scheduled to be placed at the Glass Breakwater sites during October. All clams at the Fadian holding facility were doing well at the end of the fiscal year.





Figure 1. Map of Apra Harbor showing locations of transplanted *Tridacna derasa*. Twelve clams, 6 each at 5 and 10 m, respectively were transplanted at sites A, B, C, and D. Sites E and F are scheduled to receive twelve clams each in October 1989.

## RECOMMENDATIONS

It is recommended that this project remain active as long as transplanted clams are still living. If a significant number of transplanted clams are poached, no new clams should be placed until a more suitable area for seeding is found or a marine preserve is established.

## LITERATURE CITED

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- Heslinga, G. A., T. C. Watson, and T. Isamu. 1990. Giant Clam Farming. Pacific Fisheries Development Foundation (NMFS/NOAA), Honolulu, Hawaii, 179 p.

Report prepared by: Robert F. Myers



**GUAM ENDANGERED SPECIES INVESTIGATIONS**  
**PROJECT E-1-3**  
**Section 6 - Endangered Species Act of 1973**





**JOB PROGRESS REPORT  
RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** E-1-3

**STUDY NO.:** 4

**JOB NO.:** 1

**JOB TITLE:** Captive Breeding Endangered Native Birds.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

This project is reported under Project E-1-4, Study No. 4, Job No. 1.

**JOB PROGRESS REPORT  
RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** E-1-3  
**STUDY NO.:** 4  
**JOB NO.:** 2

**JOB TITLE:** Development of an Experimental Population of Guam Rails on Cocos Island or in the Commonwealth of the Northern Mariana Islands.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

This project is reported under Project E-1-4, Study No. 4, Job No. 2.

**GUAM ENDANGERED SPECIES INVESTIGATIONS**  
**PROJECT E-1-4**  
**Section 6 - Endangered Species Act of 1973**

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-4  
STUDY NO.: 4  
JOB NO.: 1

JOB TITLE: Captive Breeding Endangered Native Birds.

PERIOD COVERED: October 1, 1988 to September 30, 1989

### SUMMARY

During FY '89 the number of Guam Rails at the DAWR facility increased from 37 to 61. The captive rail population at mainland U.S. zoos increased to more than 77. The Guam Micronesian Kingfisher population in captivity at mainland U.S. zoos, increased to 58. Construction was completed to enlarge the DAWR rail facility to a capacity of 100 rails.

### BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the Division of Aquatic and Wildlife Resources (DAWR), member zoos of the American Association of Zoological Parks and Aquariums (AAZPA) and the U.S. Fish and Wildlife Service (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982 at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately by 1984, attempts at captive breeding three of these species, the Bridled White-eye, *Zosterops c. conspicillata*, Rufous Fantail, *Rhipidura rufifrons uraniae*, and the Guam Flycatcher, *Miagra freycineti*, were abandoned due to their virtual disappearance from the wild (DAWR 1984).

The Guam Rail, *Rallus owstoni*, and Guam subspecies of the Micronesian Kingfisher, *Halcyon c. cinnamomina*, were successfully brought into captivity (DAWR 1983-6), with the capture of 19 and 31 founder birds respectively. Rails first bred at the DAWR's facility on Guam and at the Conservation and Research Center (CRC) of the National Zoological Park in 1984. Kingfishers were first bred at three mainland U.S. zoos (Bronx Zoo, Philadelphia Zoo and the Conservation and Research Center of National Zoological Park) in 1985.

During FY '88 the first studbook for the Micronesian Kingfisher was published by the Philadelphia Zoo (Bahner 1988) and the kingfisher was officially designated as a Species Survival Program species by the AAZPA. Larry Shelton, Curator of Birds at the Houston Zoo, was named Species Coordinator and Beth Bahner of the Philadelphia Zoo continued as studbook keeper. Larry Shelton was also named as the overall coordinator for the AAZPA's participation in the Guam Native Forest Bird Captive Breeding Program. Dr.



Scott Derrickson, Curator of Birds, Conservation and Research Center, National Zoological Park, Smithsonian Institution, Front Royal, Virginia is continuing as coordinator for AAZPA's Guam Rail program.

By September 30 1987, there were approximately 101 rails and 49 kingfishers in captivity on Guam and at mainland U.S. Zoos.

## OBJECTIVES

Implement and manage a captive breeding program for the Guam Rail and other endangered endemic birds by setting up facilities on Guam and at zoos on the mainland U.S. with the assistance of member zoos of the American Association of Zoological Parks and Aquariums.

## PROCEDURES

1. Continue the development of a cooperative captive breeding program for the Guam Rail and Micronesian Kingfisher with the AAZPA and its member zoos.
2. Upgrade and enlarge the Guam Rail breeding facility at the DAWR office in Mangilao to allow up to 100 birds to be held in captivity.
3. Develop techniques for the successful release of captive-reared birds in the wild once the factors responsible for their decline have been controlled.
4. Conduct studies into the breeding biology in the field on Guam of birds that are to be captive bred.
5. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
6. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.

## RESULTS

The number of Guam Rails at the DAWR's facility on Guam increased from 37 on October 1, 1988 to 61 by September 30, 1989. A total of 16 chicks were hatched from 5 clutches. There were three rail fatalities at the Guam facility during FY '89. Two were adult rails that died from trauma inflicted by their cagemates. The third was a newly hatched chick that apparently drowned in a water dish.

There are now more than 138 rails in captivity both on Guam and at the following 16 mainland U.S. Zoos:

1. Conservation an Research Center, Smithsonian Institution, Virginia
2. National Zoological Park, Washington, D.C.
3. Bronx Zoo, New York Zoological Society New York
4. Philadelphia Zoological Garden, Pennsylvania
5. Pittsburg Aviary, Pennsylvania
6. Kansas City Zoo, Missouri
7. Riverbanks Zoo, Charleston, South Carolina

8. San Diego Zoo, California
9. Lowery Park Zoo, Tampa, Florida
10. Sedgwick Zoo, Kansas
11. Baton Rouge Zoological Park, Louisiana
12. Trevor Park Zoo, New York
13. Miami Metro Zoo, Florida
14. Cincinnati Zoo, Ohio
15. San Antonio Zoo, Texas
16. Brookfield Zoo, Illinois

During FY '88 contracts were let and construction began on 22 steel framed typhoon resistant breeding aviaries at the DAWR's rail captive breeding facility in Mangilao which when completed will enlarge the capacity from 48 to 100 rails. Construction continued into the FY '89 and construction was completed in late April. On May 4, 1989, dedication of the completed facility took place with the Governor of Guam, the Honorable Joseph P. Ada, in attendance.

Dr. Susan Haig, Postdoctoral Fellow, Department of Zoological Research, National Zoological Park, Smithsonian Institution, Washington, D.C. visited Guam in April and took blood samples from all rails for genetic analysis. The results will be used to analyze the genetic relationships of the captive stock both on Guam and at mainland U.S. zoos. Optimal mating patterns will be developed in order to maximize the retention of genetic variation in the captive population.

Drs. Lyndsay Phillips a veterinarian from the CRC visited Guam in late September and continued his training of a local veterinarian and DAWR wildlife staff in sexing the Guam Rail by using a surgical laparoscope procedure.

Following the issuance of a federal permit expected during the Fall of 1989, the DAWR plans to introduce the Guam Rail to Rota during FY '90. A report on activities to date for this project appears elsewhere in this annual report under "Rota Experimental Population" Project No. E-1-4, Study No. 4, Job No. 2.

As of August 31, 1989 there were a total of 58 Micronesian Kingfishers in captivity at the following 14 mainland U.S. zoos (Bahner 1989):

1. Philadelphia Zoological Garden, Pennsylvania
2. Conservation and Research Center, Smithsonian Institution, Virginia
3. National Zoological Park, Washington, D.C.
4. Bronx Zoo, New York Zoological Society, New York
5. Pittsburg Aviary, Pennsylvania
6. Kansas City Zoo, Missouri
7. River Banks Zoo, Charleston, South Carolina
8. St. Louis Zoo, Missouri
9. San Antonio Zoo, Texas
10. Brookfield Zoo, Chicago, Illinois
11. Cincinnati Zoo, Ohio
12. Audubon Zoological Garden, Florida
13. Houston Zoo, Texas
14. San Diego Zoo, California

Of the original 29 founder kingfishers sent by the DAWR to mainland United States zoos for captive breeding beginning in 1983 (DAWR 1983-87), 17 have reproduced, 7 living

birds have not bred and 5 died before reproducing (Bahner 1989). Eleven of the original founders have died. Since the captive breeding program began, 99 kingfishers have been hatched but only 53 have survived longer than 30 days. At least 29, or 61.7%, were presumably eaten by their parents. Parent cannibalism remains the single most important cause of mortality for kingfishers at present (Bahner 1988, 1989).

AAZPA Master Plan Sessions for the kingfisher and rail are planned for November 1989 at the Conservation and Research Center of the Smithsonian Institution in Front Royal, Va. At these meetings, zoo participants in the Guam captive breeding programs will discuss problems and set future goals for the program.

## RECOMMENDATIONS

1. Develop plans for and seek funding for construction of at least six 12 stall holding aviaries to replace existing wooden aviaries that have deteriorated from weather and typhoons. Add additional holding aviaries as the need arises.
2. Develop plans and funding for the construction of a building to support food preparation areas, incubator and brooding equipment usage and storage of supplies and equipment.
3. Continue development of a cooperative captive breeding program for the Guam Rail and Micronesian Kingfisher with the AAZPA and its member zoos.
4. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.
5. Seek funding for transport of birds to zoos for captive breeding from conservation groups and other private sources.
6. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
7. Breed rails in sufficient numbers to support the introduction of the Guam Rail to Rota, Commonwealth of the Northern Mariana Islands, scheduled for late in 1989.

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Report prepared by: Robert E. Beck, Jr.



## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-4

STUDY NO.: 4

JOB NO.: 2

**JOB TITLE:** Development of an Experimental Population of Guam Rails on Cocos Island or in the Commonwealth of the Northern Mariana Islands.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### SUMMARY

Planning and implementation of preintroduction activities continued for the introduction of the Guam Rail to Rota in the Commonwealth of the Northern Mariana Islands (CNMI). The introduction originally planned for the summer of 1988 was postponed until FY '90.

### BACKGROUND

Since the creation in 1960 of the Guam Division of Aquatic and Wildlife Resources (DAWR), census data from roadside counts, station counts, and transect counts have documented the reduction in range and numbers of the Guam Rail, *Rallus owstoni*, and other native birds (DAWR 1961-1987; Jenkins 1983; Engbring and Ramsey 1984). Predation by the brown tree snake, *Boiga irregularis*, is believed to be the major factor contributing to recent declines in native bird populations (Savidge 1986, 1987; Conry 1988). Research efforts are presently underway to develop methods for controlling rail predation by the brown tree snake. However, it is not likely that we will be able to adequately control snake predation on Guam so that we will be able to introduce the rail back into the wild there in the near future .

A captive breeding program for the Guam Rail was successfully begun in 1983 on Guam and at mainland U.S. zoos in cooperation with the American Association of Zoological Parks and Aquariums (DAWR 1984-1987; Derrickson 1986). Guam Rails were first brought into captivity in 1983 on Guam and bred at the DAWR's rail facility in the spring of 1984 (DAWR 1983-4). By September 1987 there were more than 101 rails in captivity on Guam and at stateside zoos.

The DAWR is developing plans to introduce the Guam Rail to Rota in order to develop a self-sustaining wild population of rails that will not undergo "domestication" from captive breeding. It is hoped that the experience gained in introducing the rails to Rota will provide valuable information useful for future introductions on Guam. The Rota population may also serve as a partial source of birds for use in reintroducing the rail to Guam when snake predation has been controlled there.

During FY '87 a cooperative agreement was signed between the Government of Guam, CNMI, and the U.S. Fish and Wildlife Service (USFWS) outlining the responsibilities of

each entity for the introduction. An environmental assessment was prepared for the USFWS covering the introduction of the Guam Rail to Rota and forwarded to Environmental Services, USFWS, Honolulu. Upon review it was mutually decided to additionally conduct an insect and reptile survey of Rota to discover the presence of possible endangered species. Dr. Stuart Pimm, Professor of Zoology, University of Tennessee and the DAWR reached agreement by which a graduate student from the University of Tennessee will be resident on Rota for at least three years monitoring the rail introduction in cooperation with the DAWR as a part of his dissertation research. In addition, Dr. Pimm, with the support of the DAWR, applied for research grants to support the monitoring study. In April, 1987, Robert Beck from the DAWR and Dr. Pimm, accompanied by Phil Glass from the CNMI Fish and Wildlife Division, visited Rota for the purpose of investigating possible sites for the introduction. Sites in Palii and Sinapolo were tentatively selected. In addition, visits were made to various Rota government officials to update them as to the status of the project.

During FY '88, the captive breeding of the Guam Rail continued at the DAWR captive breeding facility and mainland U.S. zoos with the captive population now numbering over 120 rails. Contracts for construction of 22 additional rail breeding aviaries on Guam were let and construction began.

A survey of Rota for reptiles was conducted by Gary Wiles, DAWR, and Drs. Gordon Rodda, and Thomas Fritts, of the USFWS in February, 1988. Drs. Muniappan and Marutani of the University of Guam conducted an insect survey of Rota in February 1988. The results of both surveys, which found no endangered species, were submitted to the USFWS, Honolulu for inclusion in the Environmental Assessment for the project.

In May, 1988, Dr. Scott Derrickson, Curator of Birds and the National Zoological Park and Robert Beck visited Rota looking for additional possible introduction sites. A site on the Sabanna was selected for the initial introduction. Dr. Derrickson also transported rails to Guam to broaden the genetic variation of the Guam captive population in preparation for breeding birds for release on Rota.

In June, 1988, staff of the DAWR, with the assistance of the Rota Department of Natural Resources, constructed three 12-stall holding aviaries at the Sabana introduction site.

Radio telemetry equipment to be used to monitor the success of the introduction was purchased by the DAWR.

Dr. Stuart Pimm of the University of Tennessee was successful in receiving several grants from international conservation organizations to support his efforts in monitoring the introduction on Rota with graduate student, Greg Witteman. Using these funds, a 1/2 ton pickup truck was purchased on Rota for use by the staff monitoring the introduction.

In July, 1988 we were informed by the USFWS that there would be a delay in publication of the Final Rule required for designating the "Experimental Population" status of the rails released on Rota that would delay the introduction into FY '89.

Conservation organizations were notified of the delay so that coordination of their funding could be arranged to not cause delay of implementation of the monitoring project.

## PROCEDURES

1. Finalize permits required for the introduction from the CNMI and USFWS.
2. Captive breed Guam Rails needed for the introduction on Guam and at mainland U.S. zoos.
3. Continue to develop techniques and methods for introduction of the rail to Rota.
4. Implement disease prevention protocol with rails on Guam prior to release on Rota.
5. Implement the introduction of the Guam Rail to Rota as soon as Final Rule for designation of an experimental population is published.
6. Monitor the success of the initial introduction of Guam Rails to Rota and continue with successive introductions to the island as warranted, in cooperation with Dr. Stuart Pimm and Gregory Witteman, Department Zoology, University of Tennessee.
7. Continue to seek funding from conservation organizations to support the monitoring of the introduced rail population on Rota.

## RESULTS

During FY '89 all parties in the effort to introduce the Guam Rail to Rota prepared for the introduction while waiting for the USFWS to complete the Final Rule for the designation of the rails to be introduced to Rota as an "Experimental Population" under the Endangered Species Act of 1963. On June 19, 1989, the USFWS published the Proposed Rule to designate "Experimental Population Status" in the Federal Register. There was a 30 day comment period after which all comments would be evaluated and addressed. The final rule would then be published soon after in the Federal Register.

With the publication of the proposed Rule in June, the DAWR finalized the purchase of the 30 transmitters to be attached to the rails. In addition, Mr. Gregory Witteman, of the University of Tennessee, who will be monitoring the release, moved to Rota and set up Rota headquarters for the project in an apartment in Songsong. Dr. Stuart Pimm and Robert Beck accompanied Mr. Witteman to Rota and they met with the Mayor of Rota, Mr. Prudencio Manglona, and other Rota and CNMI Officials to update them on the status of the project. A computer electronic mail system was brought on line on Rota to assure speedy communication between all parties involved in the project.

In March, Dr. Susan Haig of the NZP was on Guam to take blood samples from the Guam Rail captive population. The samples, when combined with sampling previously done at mainland U.S. zoos, would be used for genetic analysis. This would allow individual Guam Rails to be selected from the captive population for release on Rota to insure as broad a sample of the genetic variation present in the captive population as possible.

In May, the DAWR finished construction of the expansion of the rail breeding facility on Guam that will support the Rota introduction program by providing additional holding space and increased breeding capabilities.



During August and September, several radio transmitters were attached to Guam Rails at the captive breeding facility to test the strength and durability of the harness during a visit of Greg Witteman to Guam from Rota.

On September 2, 1989, 8 Guam Rails to be used in the introduction to Rota were successfully transferred from the Conservation and Research Center of the National Zoological Park, Smithsonian Institution to Guam.

At the end of the FY '89, the Final Rule had not as yet be completed and all was in readiness on Guam and Rota for the impending release.

## RECOMMENDATIONS

1. Finalize permits required for the introduction from the Commonwealth of the Northern Mariana Islands and the U.S. Fish and Wildlife Service.
2. Captive breed Guam Rails needed for the introduction on Guam and at mainland U.S. zoos.
3. Continue to develop techniques and methods for introduction of the rail to Rota.
4. Implement disease prevention protocol with rails on Guam prior to release on Rota.
5. Implement the introduction of the Guam Rail to Rota as soon as Final Rule for designation of an experimental population is published.
6. In cooperation with Dr. Stuart Pimm and Gregory Witteman, Department Zoology, University of Tennessee, monitor the success of the initial introduction of Guam Rails to Rota and continue with successive introductions to the island as warranted.
7. Continue to seek funding from conservation organizations to support the monitoring of the introduced rail population.

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Report prepared by: Robert E. Beck, Jr.

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: E-1-4  
STUDY NO: 7  
JOB NO: 1

JOB TITLE: Biology of the Brown Tree Snake.

PERIOD COVERED: October 1, 1988 to September 30, 1989

### SUMMARY

Studies of the impact of the brown tree snake, *Boiga irregularis*, on Guam's remaining fauna and on the ecology and biology of this snake and prey species are in progress.

Information on the distribution and biology of larger *B. irregularis* indicated that these snakes are generally urban-associated on Guam. These urban habitats supply the remaining dense homeotherm prey base (chickens and rats). Analyses of these snakes revealed that not all were in the same reproductive and physiological condition. Differences in mean lengths of snakes between widely separated areas (i.e. Orote Peninsula versus Northwest Field) have been known for some time (G. Rodda, pers. comm.). Exploration of this phenomenon showed population differences that could be discerned in as little as 100 m distance. Additionally, environmental factors were explored that indicated a degree of predictability of snake activity.

In order to assess the impact of *B. irregularis* on the lizard fauna (as these organisms are the most abundant prey group remaining on Guam), eleven of fifteen species of lizards occurring on Guam were studied. Certain biological characteristics of these species indicated the species that are unable to withstand predatory pressure and those who should continue to supply a prey base for *B. irregularis*.

### BACKGROUND

Guam's native birds have declined drastically in recent decades while avian populations have remained relatively stable on nearby islands. Research indicated that *B. irregularis* was responsible for the range reductions and extinctions of the forest avifauna. Because the body of biological information (population structure, sex ratios, feeding habits, and predation) on the brown tree snake has reached a point where characterizations and generalizations are now possible (see DAWR Ann. Rep. 1981-88), more precise investigations can now be addressed and explored.

### OBJECTIVES

To determine the impact of predation by *B. irregularis* on the remaining prey populations and to study the natural history and biology of this snake and its primary prey species.

## PROCEDURES

1. Analyze data collected over the previous fiscal year on *B. irregularis* with regard to distributions, densities, reproduction, stomach contents, and environmental factors affecting movements.
2. Analyze data collected over the previous fiscal year on the remaining abundant prey group left on Guam, lizards.

## RESULTS

### *BOIGA IRREGULARIS*

#### Large Snakes

The agricultural impact of this species on Guam has been of concern for a number of years. Earlier attempts to address this impact have recently been presented by Fritts and McCoid (MS). Additionally, recent data (1988-89) on the association of snakes with poultry raisers was incorporated in the above document, lending a short-term, historical perspective to previous investigations. Savidge (1988), based on the stomach analyses of 683 snakes, proposed a scenario of feeding chronology that indicated that larger snakes (>1250 mm snout-vent length [SVL]) switch to a homeotherm prey from lizards. Since this homeotherm prey base is essentially absent in non-urban situations on Guam (Fritts, 1988; Fritts, et al.1989) or has been seriously impacted (Conry, 1988), it is reasonable to assume that larger sized snakes might be associated with regions that supply the preferred prey base. Analyses of existing data indicated that larger snakes were associated with urban situations where domesticated poultry was confined or being encouraged. With this in mind, an analysis of larger snakes (>1350 mm SVL) was conducted to evaluate general condition, reproductive status, and distribution.

A total of forty snakes >1350 mm SVL were used for analyses, although not all were used for each type of evaluation.

Distributions of >1350 mm SVL snakes are presented in Fig. 1. Of the forty snakes plotted, only three were found in non-urban situations. The northernmost non-urban associated snake was collected in a region that still supports the remaining populations of Mariana crows, Micronesian starlings, several introduced bird species, and Mariana fruit bats. Additionally, visual censuses indicate an increasing *Rattus* sp. population (M. McCoid, pers. obs.). The southern two non-urban associated snakes were collected from an area that supports the remaining population of Island swiftlets. All other snakes were collected in direct association with humans (generally in or around artificial structures).

Stomach analyses of these snakes (n=22) revealed that 72.7% (16) were empty and 27.3% (6) contained a prey item. Of those six with prey items, three had consumed chicken eggs, one a chicken, and the remaining two, rats.

Since previous investigations (J. Savidge, unpub. data) indicated that reproductive maturity may be reached at approximately 1000 mm SVL, and that large snakes appear to be associated with an abundant homeotherm prey base [(domesticated fowl or rats) this report], autopsies were performed to determine the general condition of snakes > 1350 mm



Figure 1. Distribution of *B. irregularis* >1350 mm SVL collected since October 1988 (n=40). Closed circles represent an individual collected in an urban situation. Open ovals represent an individual collected in a non-urban situation.

SVL (Fig. 2). As would be expected, the length/weight relationship displayed the highest correlation ( $R\text{-squared}=0.766$ ). The length/testes weight relationship displayed a weak, positive correlation ( $R\text{-squared}=0.304$ ) and this was also expected as there appears to be an allometric relationship (J. Savidge, unpub. data). However, the length/fat weight relationship showed no correlation ( $R\text{-squared}=0.024$ ). This was surprising in view of the seemingly abundant resource base larger snakes are associated with.



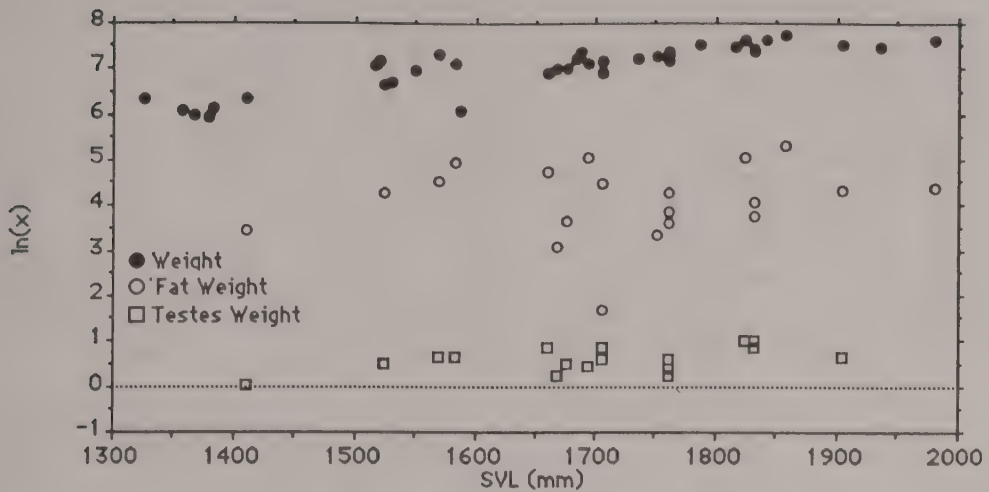


Figure 2. Length/weight (n=35), length/fat weight (n=19), and length/testes weight (n=17) relationships of *B. irregularis* >1350 mm SVL.

Visual examination of the testes showed that not all snakes were in the same reproductive condition. Expansion of this employed the use of Gonosomatic Indices (GSI's) where  $GSI = [\text{gonad weight(g)} / (\text{body weight(g)} - \text{internal organ weight(g)})] \times 100$  (Pickford, 1953). This allows a corrected view of gonadal condition (Fig. 3). Visual examination of testes revealed that all snakes with a GSI of 0.14 or less had pinkish, flaccid testes and dark reddish epididymides, probably indicating reproductive stasis. Individuals with GSI's >0.14 had turgid, whitish testes and milky-white epididymides, probably indicating reproductive activity. Thus, of the specimens autopsied, 41.2% (7) were not sexually active. It is unknown how prey availability affects reproductive condition, but fat weight and testes weight were not correlated (n=17; R-squared=0.01) indicating that reproductive status may not be related to how well the snake has been eating.

Figure 4 explores the relationship between month of collection and GSI's. As can be seen, no relationship is discernable and specimens with GSI's <0.14 occur year-long. There appears to be an aseasonality with respect to both active and inactive testes.

### Area Effects

During FY '89, a 20.9 km stretch of Routes 4 and 10 was driven on a virtual daily basis between approximately 0700 and 0800 h. Locations and approximate lengths were estimated for road-killed snakes (hereinafter referred to as DOR's) (Fig. 5). While DOR's could be observed anywhere along the course, they were recorded most frequently at four locations: the village of Yona, the vicinity of the Togcha River, the vicinity of the Talofoto River (including the Asalonso River), and the village of Malojloj. Assuming each of these areas of DOR concentration represents a somewhat discrete population, some comparisons can be made (Table 1.)

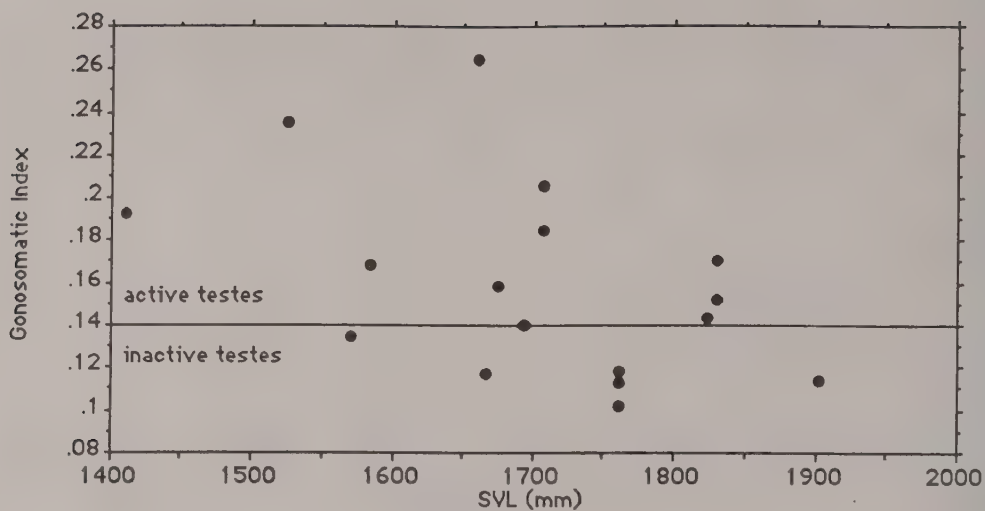


Figure 3. GSI's versus SVL for *B. irregularis* >1350 mm SVL (n=17).

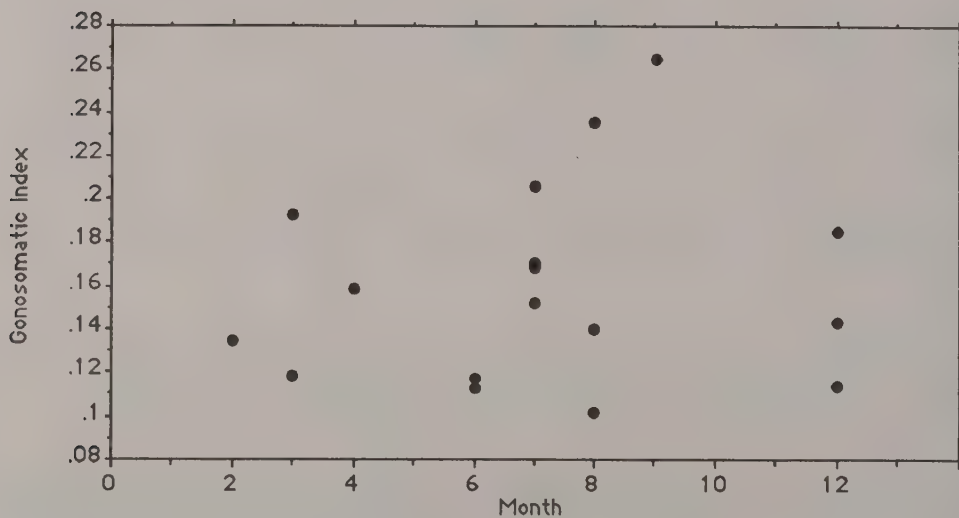


Figure 4. GSI's versus month of collection for *B. irregularis* >1350 mm SVL (n=17).

Table 1. Statistical information on *B. irregularis* lengths of the four DOR localities.

|             | <u>Malojloj</u> | <u>Talofoto</u> | <u>Togcha</u> | <u>Yona</u> |
|-------------|-----------------|-----------------|---------------|-------------|
| n           | 15              | 14              | 8             | 9           |
| mean length | 1208.93         | 838.0           | 906.25        | 1015.778    |
| SD          | 417.421         | 325.618         | 340.618       | 401.102     |
| variance    | 174240.154      | 106026.786      | 116179.694    | 160882.495  |
| CV          | 33.178          | 49.812          | 35.93         | 33.556      |

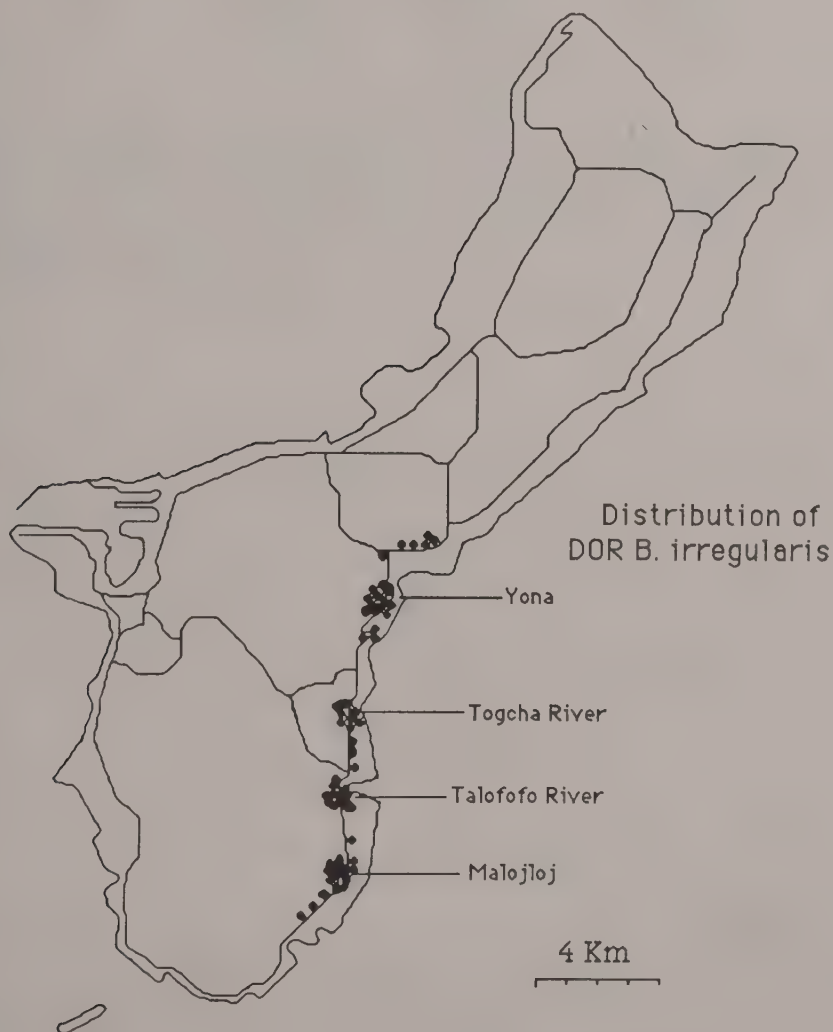


Figure 5. Distribution of DOR *B. irregularis* observed in FY '89. Each dot may represent more than one individual (n=71).

An  $F_{\max}$  test was conducted on the four DOR localities ( $F_{\max} .05(4,7) = 8.44$ ;  $F_{cal} = 1.6434$ ) to test differences in variances and showed that they were homogeneous. Population means of the four localities were then tested for equality according to Gabriel (1978) (Table 2).

Table 2. Results of the Gabriel Test for Equality for the four DOR localities.

|             | <u>Malojloj</u> | <u>Talofolo</u> | <u>Togcha</u> | <u>Yona</u> |
|-------------|-----------------|-----------------|---------------|-------------|
| mean SVL    | 1208.93         | 838.00          | 906.25        | 1015.778    |
| upper limit | 1221.32         | 850.61          | 920.75        | 1029.858    |
| lower limit | 1196.54         | 825.61          | 891.75        | 1001.698    |

Since none of the upper and lower limits overlap (test conducted at the .05 level) between localities, it is safe to assume that the means of each of the populations are different. It is important to notice that the two largest means are urban areas while the two smallest means are from non-urban regions. This correlates well with assumptions regarding the increased dependence of larger snakes on urban situations for a prey base and may show differences in populations within a relatively short distance. Implicit is that population characteristics may reflect relatively localized conditions (i.e. prey availability).

### Site Specific Investigations

The majority of investigations on *B. irregularis* on Guam have taken place in the central or northern sections of the island. Because of this, a need was identified to garner information on populations of snakes from southern Guam. A study site was selected on Government of Guam land in Malojloj and a one hectare plot established in secondary forest dominated by *Leucaena*, *Scaveola*, and *Pandanus*. Eleven parallel trails (1100 m total) were cut 10 m apart and each trail marked at 5 m intervals with a unique number. This system yielded a study grid with 231 stations that allowed relatively precise plotting of data points. Approximately two nights per week (4 h each) were spent on the grid from July to present and observations of potential prey and *B. irregularis* were recorded on a schematic of the grid. Unfortunately, observations of *B. irregularis* on the grid have been disappointing with only five seen or captured. Because of this, the grid was halved to maximize the number of observations of prey items and intensively study a smaller area. Six hundred (600) meters of trail were utilized. Potential prey encountered were *Gehyra mutilata*, *G. oceanica*, *Lepidodactylus lugubris*, *Hemidactylus frenatus*, *Carlia fusca*, *Emoia caeruleocauda*, *Rattus exulans*, and *Gallus gallus*. Discussions of lizard densities on the study grid are presented below. The *Rattus* observation was of a single individual and *Gallus* was heard, but never observed.

Despite the fact that only five snakes were obtained from the study grid, initial, albeit tenuous, inferences can be made. Nine additional snakes were collected from an area approximately 100 m west of the western boundary of the grid and were used as comparative material. A fundamental difference between the study grid and this second location is that the latter has abundant homeotherm prey items (chickens and rats). Comparisons of the sites are presented in Table 3.



Table 3. Comparison of population length characteristics of *B. irregularis* from two localities in southern Guam.

|          | <u>Malojloj grid</u> | <u>Malojloj urban</u> |
|----------|----------------------|-----------------------|
| n        | 5                    | 9                     |
| mean SVL | 678.6                | 1039.889              |
| SD       | 129.793              | 251.864               |
| variance | 16846.3              | 63435.611             |
| CV       | 19.127               | 24.22                 |

A two-tailed F-test ( $F_{.025(8,4)} = 8.98$ ,  $F_{cal} = 3.7655$ ) was conducted on the variances of these two areas (Sokal and Rohlf, 1981) and they were found to be heterogeneous. Means were not tested. What is important to notice from the Malojloj data is that differences in variances of populations may be statistically inferred in as little as 100 m distance.

### Reproduction and Behavior

Analyses of unpublished J. Savidge data on the persistence of the umbilical scar indicated that reproduction of *B. irregularis* may be aseasonal on Guam (G. Rodda, pers. comm.), although it appears to be seasonal in Australia (H. Greene, unpub. data). Examination of field collected specimens and DOR observations showed that snakes approximately 350 mm SVL were only observed in August through October. Because hatchling-sized snakes are recorded only over a three month period, this periodicity of observations may indicate that reproduction is seasonal on Guam.

On 13 June 1989, a female *B. irregularis* (size unknown) oviposited a clutch of five shelled eggs and four unshelled eggs in a display cage. The shelled eggs were discovered dessicated but approximate lengths ranged from 30 to 34 mm. These eggs could represent two separate clutches (from two snakes as there were five snakes in the cage) or a single clutch (five good eggs and four slugs), with the four slugs being deposited early because of the stress of captivity. Credence for the latter hypothesis is supplied from a closely related species, *B. dendrophila*. John Groves (pers. comm.) has observed *B. dendrophila* depositing two clutches of eggs within a period of three or four weeks. Considering the above information, Guam *Boiga* may reach the upper clutch size of 4-12 mentioned by Zwinenberg (1978) by double clutches.

A particularly enigmatic problem concerning Guam populations of the brown tree snake has been sex ratios. Since 1986, all snakes collected >1350 mm SVL have been males. Prior to 1986, almost all snakes collected >1350 mm SVL were also males. Thus almost all larger snakes collected on Guam have been males. While these snakes constitute a relatively small proportion of the total population, the absense of females remains puzzling.

Shine (1978) suggested that size dimorphisms between the sexes may be related to male combat. Until this year, this phenomenon had not been observed on Guam. On 31 August 1989, two males (1188 mm and 1525 mm SVL) were observed crawling vertically up a trunk of a tree at 2130 h. They were side-by-side and exhibited head-touching behavior and bobbing and weaving. The larger male appeared to dominate and remained superior most of the time. Autopsies revealed that both had whitish, turgid testes and apparently had sperm in the epididymides. Unfortunately, while the size discrepancy may be

explained by male combat, the sex ratio discrepancy is not, particularly in view of the high proportion of males in this larger size class that appeared to be sexually inactive (Fig. 3). Selection pressure would not be operating on post-reproductive individuals.

### Environmental Correlates

Fritts, et al. (1987) showed that *B. irregularis* caused power outages on Guam by climbing power poles and that there was a seasonal component that coincided with the beginning of the rainy season. A major assumption that researchers have made, perhaps based on somewhat anecdotal information, is that activity of *B. irregularis* is triggered by rainfall. There may, however, be several types of activity patterns that might be a response to particular environmental conditions.

Based on the almost daily record of DOR's (Fig. 5), an environmental correlation can be made. Daily environmental conditions are recorded for the Mangilao station by the Division of Forestry, Department of Agriculture. Many measurements are taken or calculated, including Drought Factor, which is a relationship between the number of days since the last rain and daily high temperature (N. Hendricks, pers. comm.). Plotting Drought Factor and Boiga sightings against day of data collection yielded Fig. 6. Any deviation from zero represents an increasingly drier situation.

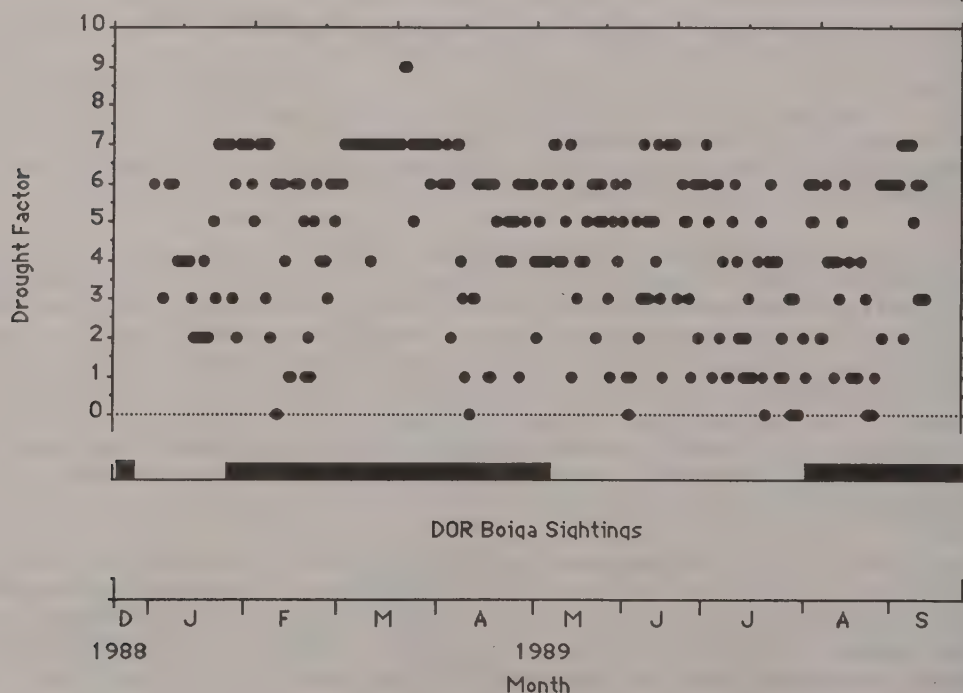


Figure 6. Drought Factor versus date of data collection and DOR *Boiga* sightings. Scale on the y-axis is 0=wet and 9=very dry. Darkened horizontal bars indicate the span of dates on which *Boiga* was recorded on the road.

Figure 7 represents the number of DOR *B. irregularis* observed for a given Drought Factor score. While there was some overlap between *Boiga* sightings and low Drought Factor (possibly explained by DOR's being observed in areas (southern Guam) other than where weather conditions were being recorded (central Guam)), there was still a tendency for *B. irregularis* to be observed exhibiting terrestrial activity as the Drought Factor increased (Fig. 7). Data in Fig. 7 indicate that over twice as many snakes were observed during drier conditions. While environmental correlates of arboreal activity have not been examined, data indicate that terrestrial activity may be somewhat predictable based on Drought Factor. It should be stated that comparison of daily rainfall to DOR records did not reveal any discernable pattern.

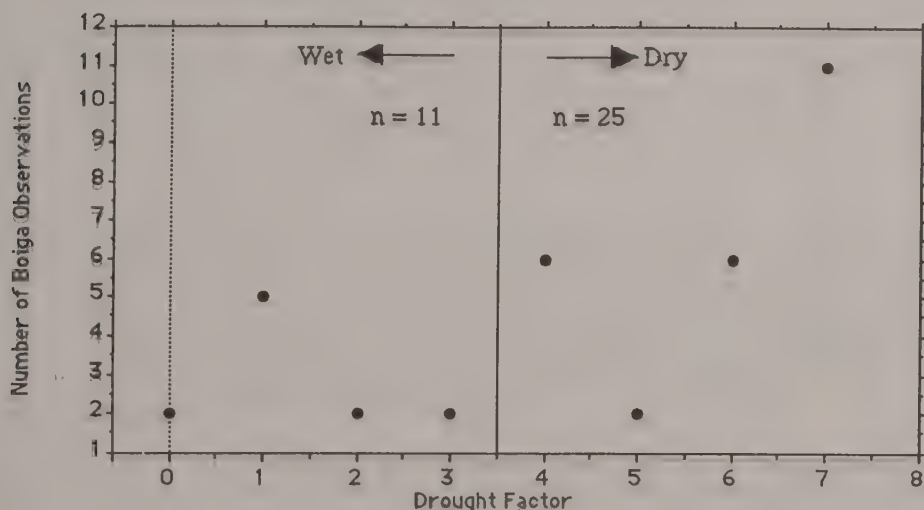


Figure 7. Number of DOR *B. irregularis* observed plotted against Drought Factor. The vertical line represents the midpoint of Drought Factor scores that snakes were collected under.

### EMOIA CYANURA

The distribution of this species is enigmatic. While this species is widely distributed in the Pacific Basin (Ineich and Blanc, 1988), the only museum records for the Mariana Islands are from Cocos Island, although Kami, et al. (1974) recorded this species from the Geus River valley, near Merizo, Guam. Observations of *E. cyanura* on Cocos Island indicate that densities may be relatively high, although they appear to be restricted to the relatively undisturbed western 2/3's of the island. This species has been observed foraging on the ground or in low vegetation, mirroring what Schwaner (1980) observed in American Samoa.

### Length/Weight Relationships

Only five specimens have been collected and weights were recorded on four. Figure 8 shows a relationship, but it should be regarded as equivocal because of the paucity of specimens.

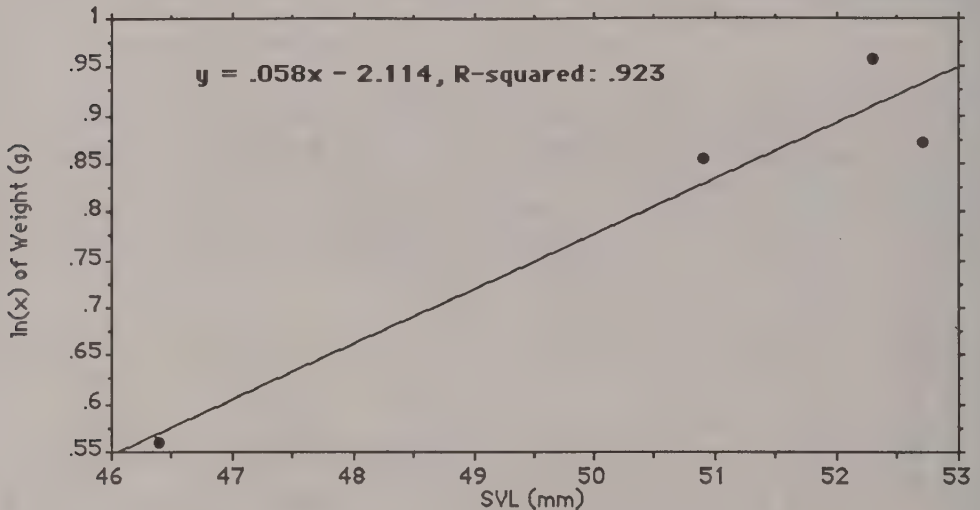


Figure 8. Length versus weight relationship for combined sexes of *E. cyanura*.

### Reproductive Patterns

Males--Little can be discerned as only one male was collected. The specimen was 50.9 mm SVL and had well developed epididymides indicative of sexual maturity.

Females--Four specimens were analyzed (Fig. 9). Initiation of vitellogenesis may occur at approximately 1.5 mm diameter. The 46.4 mm SVL individual had begun vitellogenesis but had oviducts that were thin and translucent, indicative that oviposition had not as yet occurred. All other females had thickened, opaque oviducts. Sexual maturity may be inferred as occurring in females larger than approximately 47 mm SVL. Schwaner (1980) reported attainment of sexual maturity for this species in American Samoa at approximately 40 mm SVL.



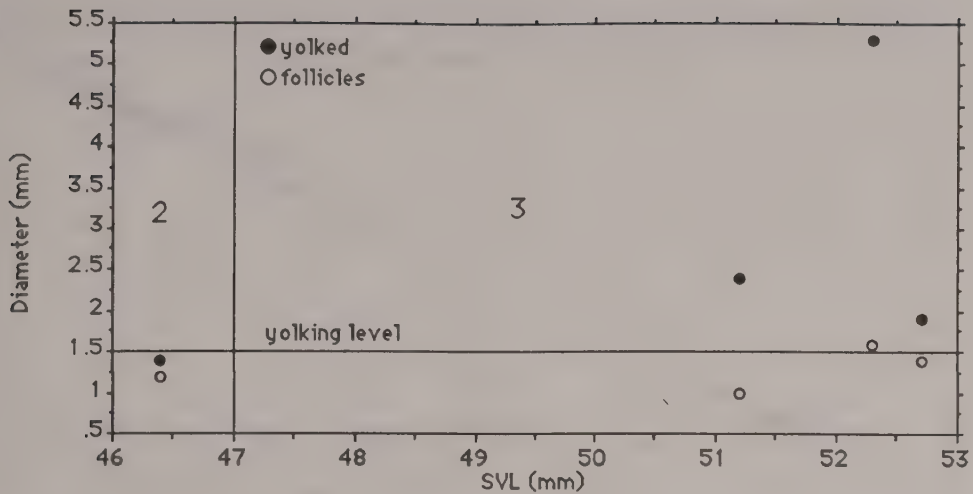


Figure 9. Length versus follicular development for *E. cyanura*. Boxed numbers refer to reproductive classification: 1. Gonadal differentiation but no vitellogenesis and oviducts thin and translucent = immature; 2. Vitellogenesis initiated but oviducts translucent = maturing; and 3. Oviductal eggs present or oviducts thickened and opaque indicating prior oviposition = mature. Yolking level is an arbitrary, although plausible, compromise between the smallest vitellogenic and largest non-vitellogenic follicles observed.

Several juveniles (circa 30 mm SVL) were observed on Cocos Island in September 1989. No conclusions on seasonality of reproduction can be inferred from the above data although Schwaner (1980) reported reproductively active females throughout the year on American Samoa.

### *EMOIA CAERULEOCAUDA*

This species of skink was recorded on Guam prior to 1906 (Van Denburgh, 1917). Van Denburgh regarded this species as "very plentiful" and observed specimens primarily on the ground or on low objects. This species is widespread in the Mariana Islands (C. Rodda, pers. comm.) and examination of specimens housed at the California Academy of Sciences indicated that the range appears to include the Caroline, Mariana, and Solomon Islands, and New Guinea.

#### Length/Weight Relationships

Analysis of 82 specimens provided the relationship described in Figure 10.

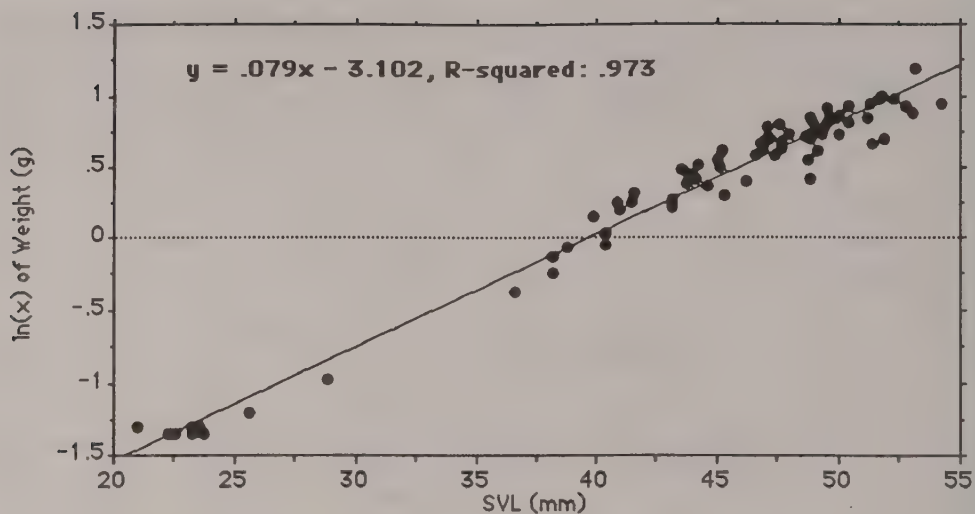


Figure 10. Length versus weight relationship for combined sexes of *E. caeruleocauda*.

### Reproductive Patterns

Males--Analyses of 57 specimens revealed that all specimens less than 40 mm SVL were immature. Maturing specimens were between 40 and 43 mm SVL, while all specimens greater than 43 mm SVL were mature (Fig. 11).

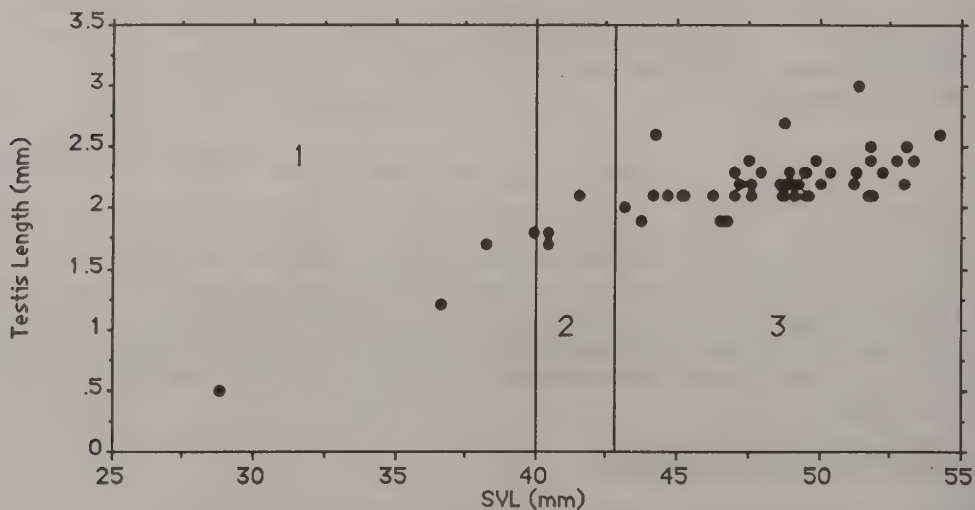


Figure 11. Length versus testis length for *E. caeruleocauda*. Boxed numbers refer to reproductive classification: 1. Gonadal differentiation but no epididymides evident = immature; 2. Initiation of development of epididymal tissues = maturing; and 3. Developed epididymides = mature.

Females--Analyses of 17 specimens yielded the following scenario (Fig. 12). Specimens less than 41 mm SVL were immature, those between 41 and 43 mm SVL were maturing, and those larger than 43 mm SVL were mature.

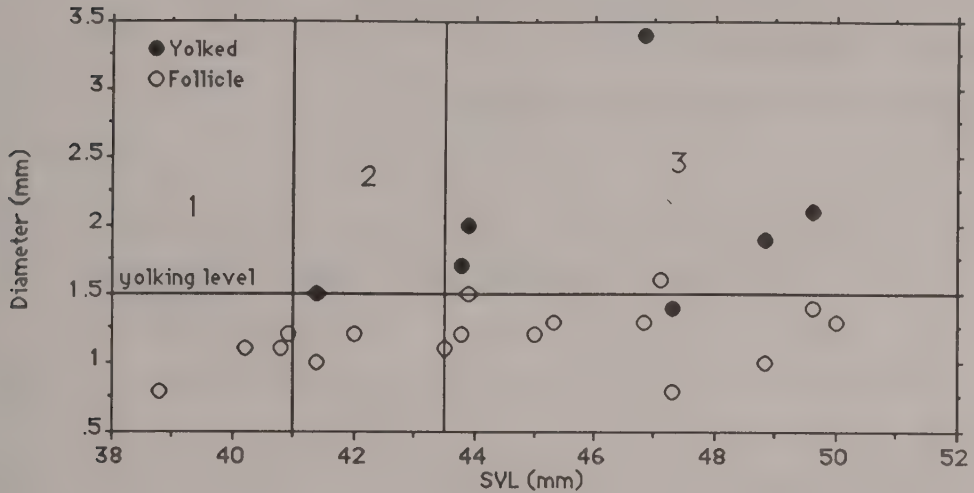


Figure 12. Length versus follicular development in *E. caeruleocauda*. Symbols as in Fig. 9.

Size at maturity for both sexes then, is approximately 43 mm SVL. Vitellogenesis begins at approximately 1.5 mm diameter and shelling of vitellogenic follicles occurs at sizes greater than 3.4 mm diameter. Clutch size is apparently an invariant two. While only nine hatchlings have been obtained from incubated eggs, year-long observations of hatchling-sized individuals in the wild indicate that reproduction is aseasonal on Guam. Interestingly, sex ratios of this species from a research site in northern Guam (Northwest Field) are skewed in favor of males (1 male : 0.244 females). This warrants further investigation but it may be related to capture techniques.

### *CRYPTOBLEPHARUS POECILOPLEURUS*

This species occurs on many Pacific Islands (Gibbons, 1985; Ineich and Blanc, 1988) including the Mariana Islands. However, perhaps because of small size and inconspicuous habits (see below), it is poorly represented in museum collections (M. McCoid, pers. obs.). Observations of this species on Guam are rare (G. Rodda, pers. comm.) and may be related to the above attributes. However, on Cocos Island, the species is an abundant and conspicuous member of the herpetofauna. Most observations made were on the trunks of *Casuarina* sp., although a few were recorded on *Cocos* sp. and unidentified trees. All

observations involved one or two individuals per trunk. In the Malagasy Republic, this species apparently employs a large amount of terrestrial activity (Fricke, 1970) with daily migrations to feed in the inter-tidal zone. Since this terrestrial activity has not been observed on Cocos Island, it is likely that the species may be more arboreal than in other portions of the range. Observations of this species on Rota Island (Commonwealth of the Northern Mariana Islands (CNMI)) indicated that the species may be semi-arboreal (G. Wiles, pers. comm.). Wiles, et al. (1989) reported this species as occurring on *Leucaena* on Tinian Island (CNMI), perhaps indicating some degree of arboreality.

### Length/Weight Relationships

An analysis of 35 specimens is presented in Fig. 13.

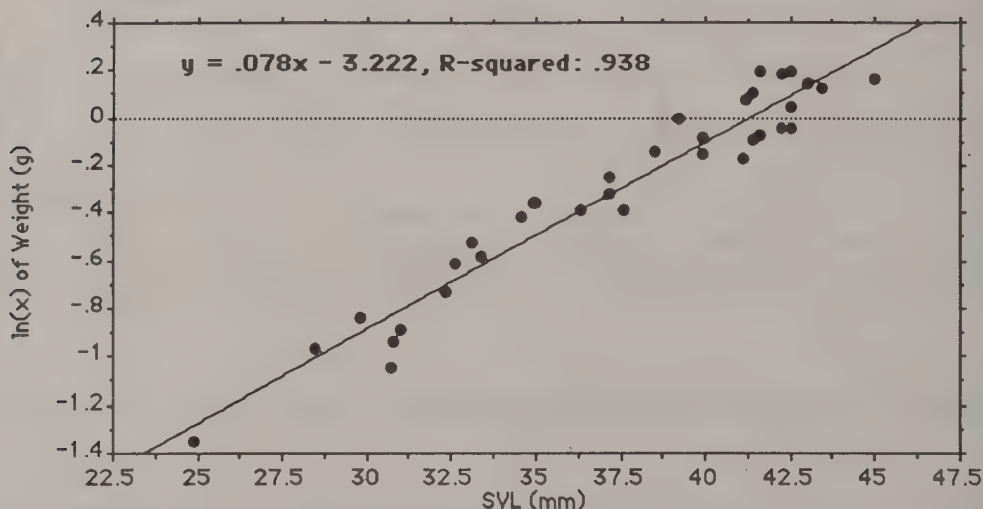


Figure 13. Length versus weight relationship for combined sexes of *C. poecilopleurus*.

### Reproductive Patterns

Males--Figure 14 describes the maturation pattern for this species. Analyses of 16 specimens revealed that all males less than 35 mm SVL were immature. Males between 35 and 38 mm SVL were considered as maturing, and those greater than approximately 38 mm SVL as mature.



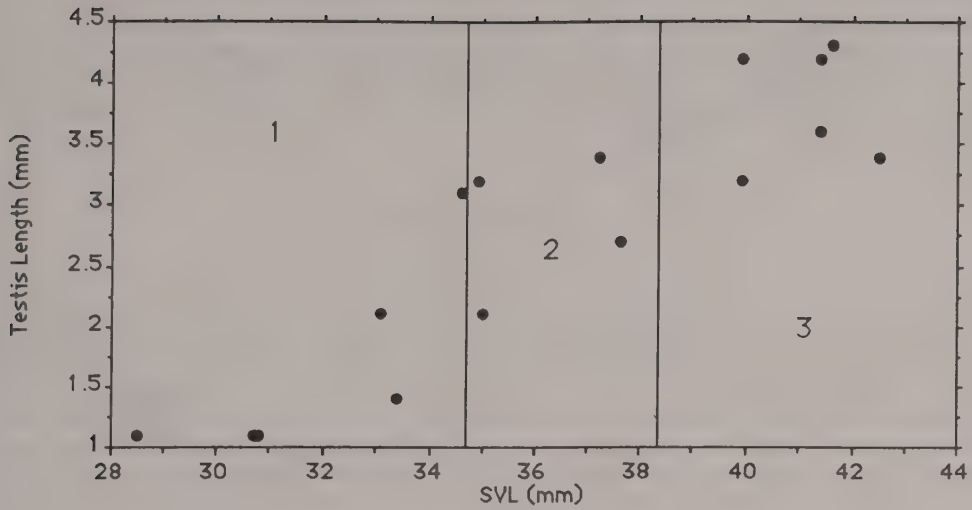


Figure 14. Length versus testis length for *C. poecilopleurus*. Symbols as in Fig. 11.

Females--Analysis of 17 specimens indicated the following picture (Fig. 15). Specimens less than 37 mm SVL are immature, while those over 38 mm SVL are mature.

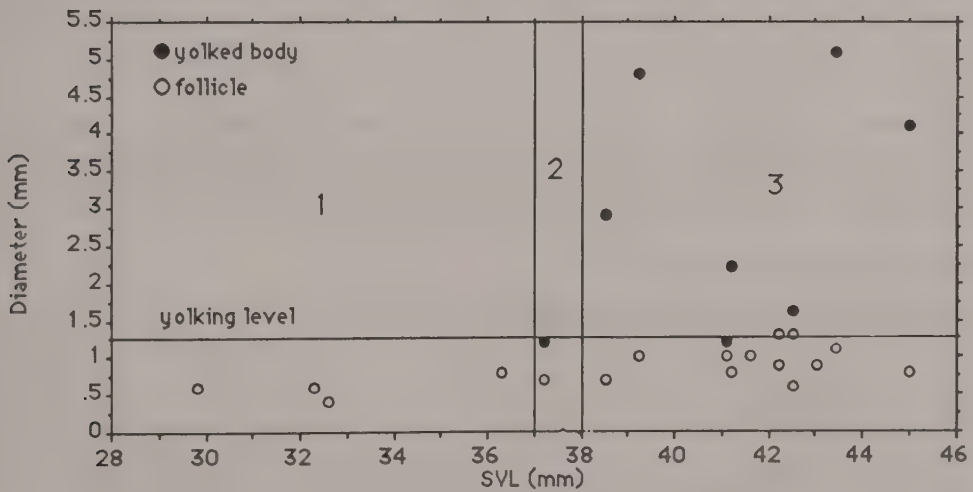


Figure 15. Length versus follicular development in *C. poecilopleurus*. Symbols as in Fig. 9.

Vitellogenesis begins at approximately 1.25 mm diameter and shelling of follicles occurs at sizes greater than 5.1 mm diameter. The mean number of oviductal eggs is 1.57 per clutch. Schwaner (1980) believed that clutch size in this species was a constant two in American Samoa and that reproductive maturity for males was reached at 38-40 mm SVL and 40 mm SVL for females. Excepting mean clutch size, data on Guam specimens resembles that assembled by Schwaner (1980).

### **CARLIA FUSCA**

*Carlia fusca* is an introduced species on Guam. The earliest record for Guam, based on specimens deposited at the California Academy of Sciences, is 1968. Collections from Guam, made in the mid-1950's, did not contain *C. fusca*. The window for introduction, then, is approximately 10 to 15 years. Presumably, populations of *Carlia* were relatively dense by 1968 as a number of specimens were collected and they were collected in Mangilao, well away from official entry points (port facility and airports). Assuming this introduction was accidental and the species was introduced at an entry point, a considerable portion of the island had been colonized by 1968. This pushes the date of introduction back to perhaps the late 1950's or early 1960's.

The origins of *C. fusca* on Guam may remain obscure until sophisticated population identification techniques are employed (e.g. electrophoresis). Examination of 480 specimens housed at the California Academy of Sciences collected from New Guinea revealed that two pattern morphs exist (striped and unpatterned). Of the localities in New Guinea that had a sample size greater than 20, the percentage of unpatterned morphs ranged from 0 to 23%. All *C. fusca* on Guam are patternless. Cogger (1986) stated that native populations of *C. fusca* occurred in Queensland, Australia and islands in the Straits of Torres and that both pattern morphs were present. Populations in New Guinea are considered extralimital (Cogger, 1986). McCoy (1980) felt that *C. fusca* might be introduced in the Solomon Islands from New Guinea. Both pattern morphs are also present on Bougainville Island.

At this time, *C. fusca* is island-wide and is, by far, the most abundant skink, in both urban and non-urban situations, on Guam. Notably, in highly disturbed situations, (e.g. mowed yards), *C. fusca* is the only species of skink present. Implicit is that this species may be highly tolerant of novel conditions and could be characterized as an excellent colonizer.

#### **Length/Weight Relationships**

Data collected on 201 specimens is presented in Figure 16.

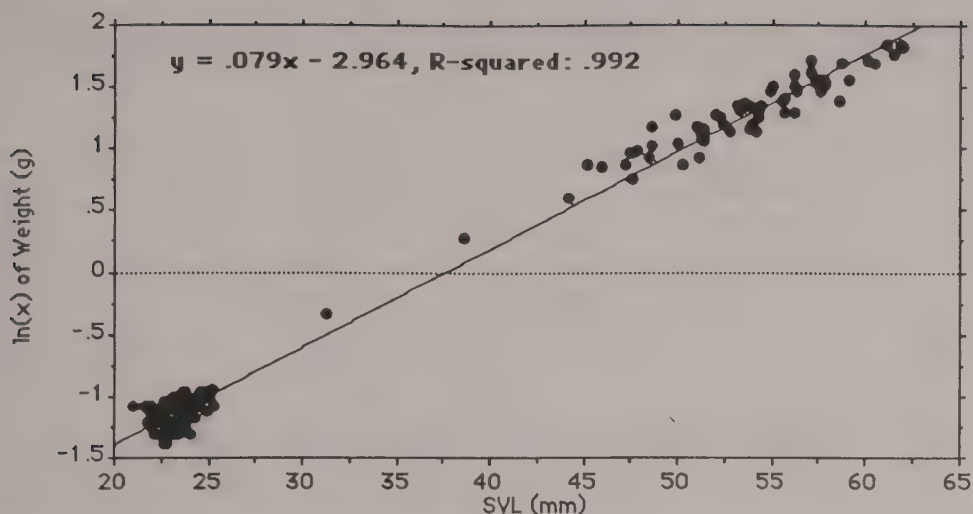


Figure 16. Length versus weight relationship for combined sexes of *C. fusca*.

### Reproductive Patterns

Males--Reproductive status was analyzed for 50 specimens and is presented in Fig. 17. Based on autopsies, males less than 47 mm SVL are considered immature. Between approximately 47 and 51 mm SVL, maturation occurs and after approximately 51 mm SVL all specimens are considered mature.

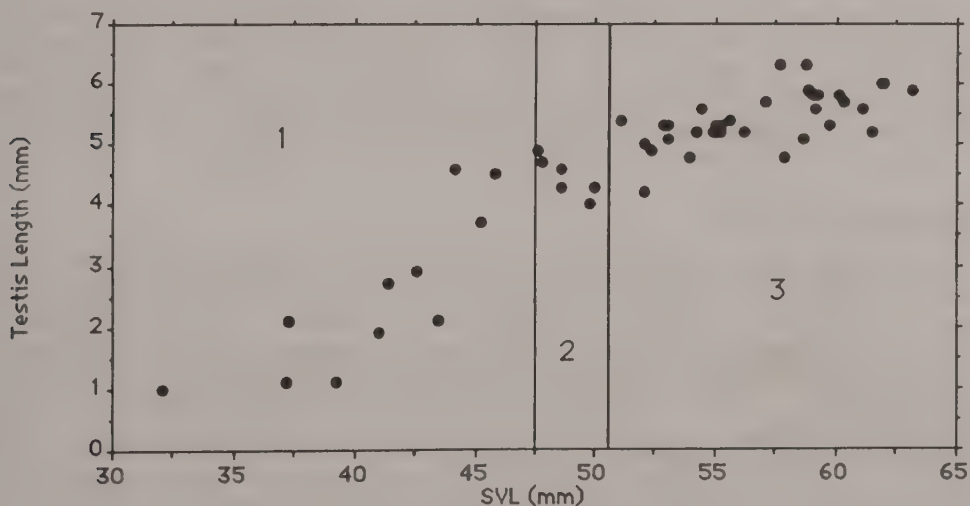


Figure 17. Length versus testes length for *C. fusca*. Symbols as in Fig. 11.

Females--Analyses of 46 specimens resulted in Fig. 18. Specimens less than approximately 43 mm SVL are considered immature. Maturation occurred between approximately 43 and 51 mm SVL and all specimens over 51 mm SVL were mature.

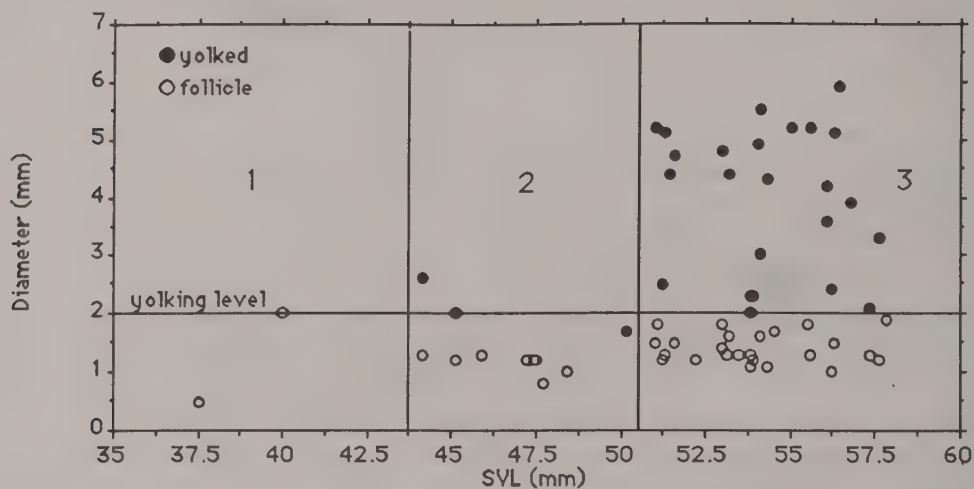


Figure 18. Length versus follicular development for *C. fusca*. Symbols as in Fig. 9.

McCoy (1980), in an extralimital population, mentioned an invariant clutch size of two. On Guam, this species also has an invariant clutch size of two. Hatchlings and eggs have been collected year-long indicating continuous, aseasonal reproduction. Vitellogenesis of follicles begins at approximately 2.0 mm diameter. Three stages of ova can be simultaneously present within a given female: non-vitellogenic follicles, vitellogenic follicles, and oviductal eggs. Vitt (1986) viewed this as evidence for a single female producing multiple clutches per year.

### Hatchling Information

Data on 103 hatchlings was amassed by incubating field collected eggs. Maximum days of incubation are 34 to 35. This figure was validated in that known sites of egg deposition were checked on a daily basis and any eggs found, collected. Analyses of length/weight relationship for hatchlings is presented in Figure 19. A positive, but weak, relationship is evident ( $R^2 = 0.279$ ). The relationship between SVL and egg weight was slightly higher ( $R^2 = 0.302$ ). Figure 20, hatchling weight versus egg weight, showed the strongest correlation.



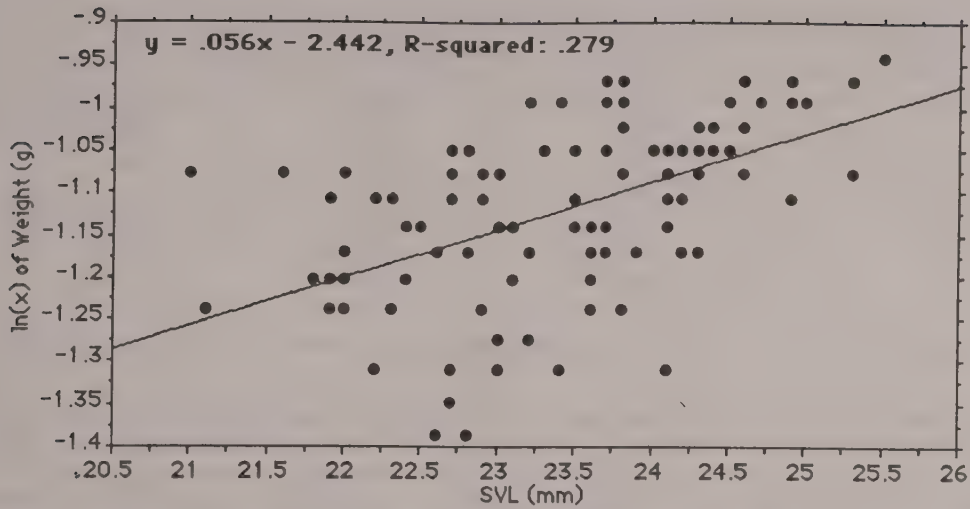


Figure 19. Length versus weight relationship for hatchling *C. fusca*.

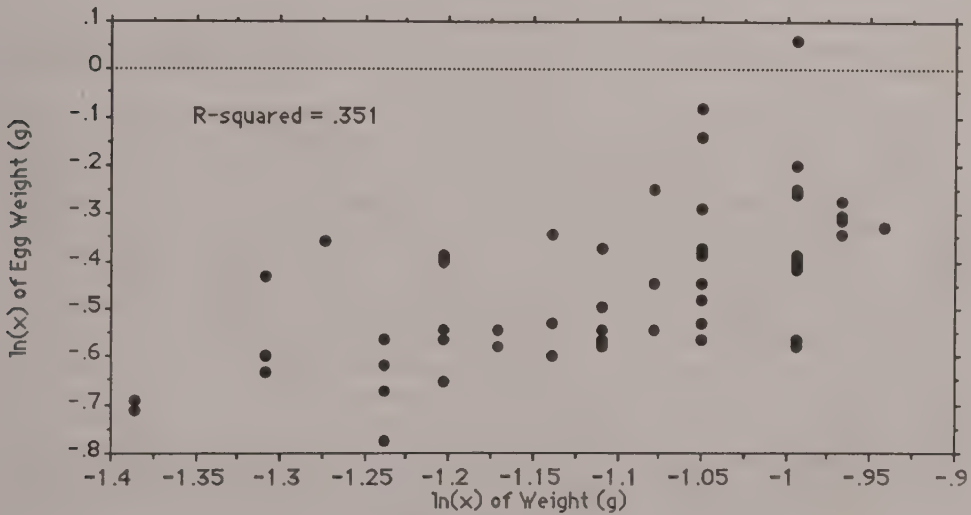


Figure 20. Weight versus egg weight relationship for hatchling *C. fusca*.

Pertinent statistics on hatchlings are presented in Table 4. Examination of the Coefficients of Variation shows that the greatest amount of variation is contained in the category "egg weight". This data was recorded within seven days of hatching for each egg and it was observed that intra-clutch variability was always much less than inter-clutch variability for all parameters measured. It was also noted that when clutchmates were incubated separately, they still paralleled each other in all parameters indicating a parental or genetic component to development.

Table 4. Statistical characteristics of hatchling *C. fusca*.

|          | <u>Weight</u> | <u>SVL</u> | <u>Egg Weight</u> |
|----------|---------------|------------|-------------------|
| n        | 103           | 103        | 62                |
| mean SVL | .328          | 23.408     | .646              |
| SD       | .033          | .966       | .11               |
| range    | .25-.39       | 21-25.5    | .46-1.06          |
| variance | .001          | .932       | .012              |
| CV       | 10.064        | 4.125      | 16.994            |

Vitt (1986) found that female size was not correlated with size of eggs oviposited. This was also found to be the case in *C. fusca* (Fig. 21). The causes for the relatively large range of egg weights remains unexplored and it may be tied to resources available to the female during the reproductive cycle, or there may be a genetic component, i.e. certain females lay larger eggs.

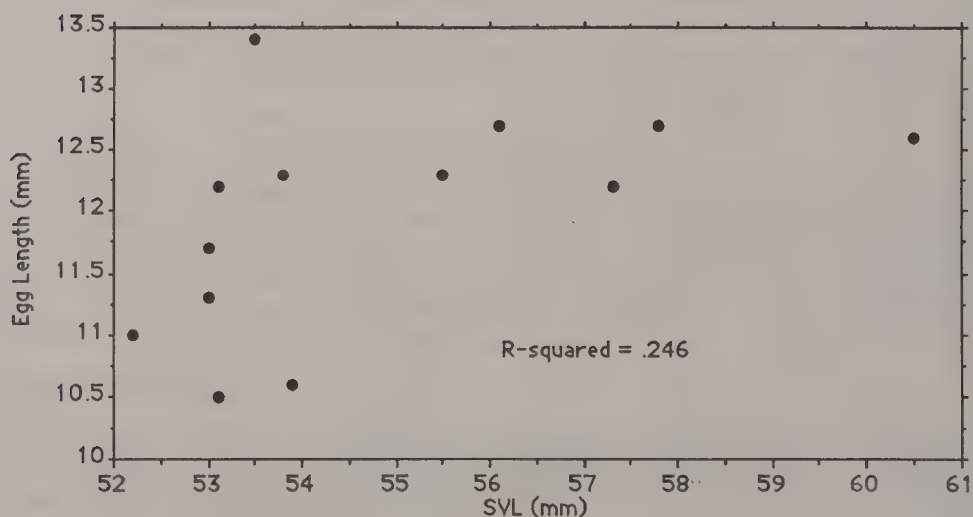


Figure 21. Length versus egg length relationship of *C. fusca*.

Survivorship of hatchlings is potentially influenced by egg weight. A small number of eggs were allowed to dessicate to varying degrees and then rehydrated. Data on these are presented in Table 5. While the data are preliminary, it is important to speculate on the

significance of surface to volume ratios. Smaller eggs will dessicate at a faster rate than larger eggs. This may allow higher survivorship of eggs that weigh more during the dry season or during droughts. Comparison of SVL's of hatchlings from dessicated eggs with those in Table 4 show them to be essentially identical indicating that losing up to 30% of the weight of the egg (provided rehydration occurs) does not effect the size of the hatchling or egg viability.

Table 5. Dessication of *C. fusca* eggs (n=7).

| <u>% Weight Loss</u> | <u>Hatching Success</u> | <u>SVL</u> |
|----------------------|-------------------------|------------|
| 10.9                 | yes                     | 22.0       |
| 11.1                 | yes                     | 24.6       |
| 14.6                 | yes                     | 22.7       |
| 18.8                 | yes                     | 23.7       |
| 26.0                 | yes                     | 23.8       |
| 29.3                 | yes                     | 22.7       |
| 33.3                 | no                      | ----       |
|                      |                         | mean=23.25 |

### Population Studies

A total of 23 *C. fusca* were marked and released on the Malojloj study grid. Marking was done by painting a unique number on the dorsum to facilitate identification from a distance. Unfortunately, data from this exercise are equivocal. Within a two week period, all marked individuals had disappeared. Reasons for this may be two-fold: the paint may stimulate shedding and *C. fusca* may not exhibit home ranges. A related species, *C. rostralis*, was studied in Queensland, Australia and found to exhibit home ranges (J. Whittier, pers. comm.). Male home ranges were considerably larger than females' home ranges. Of the 23 marked *C. fusca*, nine were sighted again within a two week period. Four (three males, one female) had remained within a two meter radius of the marking station, while five (three males, two females) had moved between five and ten linear meters from the marking site. Using this meager data suggests that either *C. fusca* exhibits very large home ranges or that home ranges do not exist. The latter hypothesis is supported by observations of this species involving up to four adults simultaneously basking in a patch of sunlight (0.3 m<sup>2</sup>) with little or no observed interaction. Individuals were highly tolerant of each other and the only active interactions observed appeared to be males chasing females with the end result being copulation.

### **PEROCHIRUS ATELES**

This species was apparently widely distributed on Guam until at least 1969 (Sabath, 1981). By 1988, populations on Guam had either been extirpated or were at such low levels as to be undetectable. At this time, the only known remaining population on Guam occurs on Cocos Island.

### Length/Weight Relationships

Fifteen specimens of both sexes were analyzed and are presented in Figure 22.

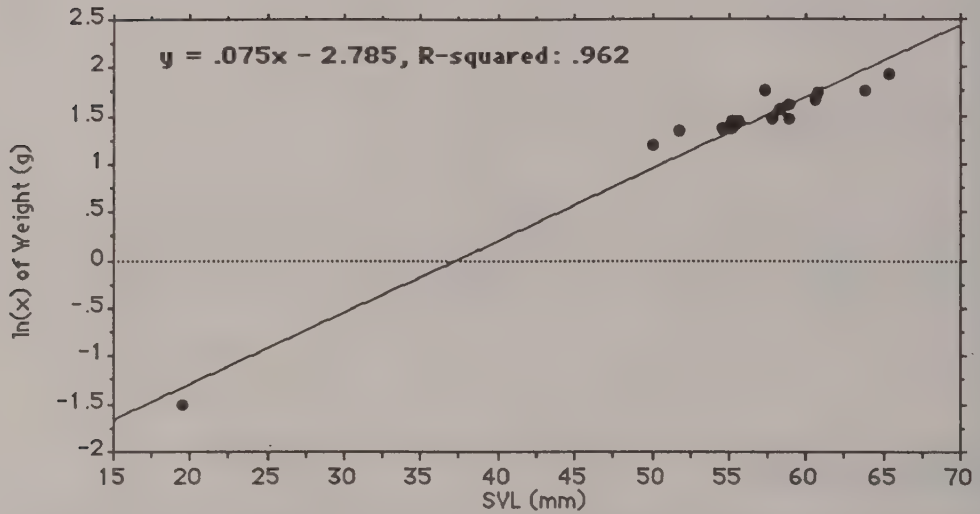


Figure 22. Length versus weight relationship for *P. ateles*.

### Reproductive Patterns

Males--The reproductive pattern for this species was based on the examination of nine specimens and is presented in Fig. 23. The smallest male had internally discernable testes but no epididymide development and was regarded as immature. Maturing males are between approximately 53 and 58 mm SVL and all those larger than 58 mm SVL are regarded as mature.



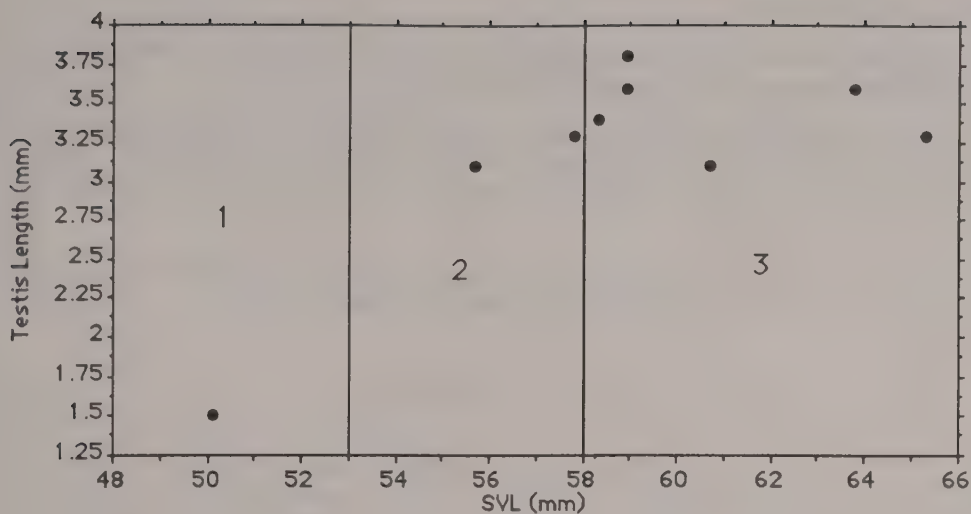


Figure 23. Length versus testis length for *P. ateles*. Symbols as in Fig. 11.

Females--The smallest female collected (51.8 mm SVL) contained a single oviductal egg (Fig. 24.). All specimens collected were considered adults. Since the smallest female contained a single oviductal egg (the other oviduct was thin and translucent, indicating no prior oviposition), the average clutch size is less than two.

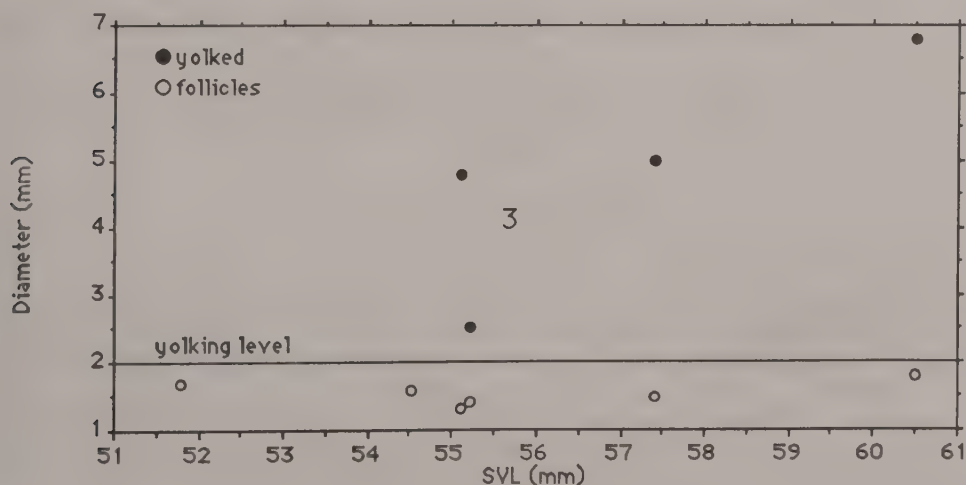


Figure 24. Length versus follicular development for *P. ateles*. Symbols as in Fig. 9.

### Eggs and Hatchlings

A hatchling (19.5 mm SVL) was collected in September 1989 and a female collected in April 1989 oviposited two eggs (one 12 May and the second 14 May).

Examination of specimens housed at the California Academy of Sciences revealed that hatchling-sized specimens were collected in February and August on Pohnpei. Synthesis of the above with data on Guam specimens indicates that the reproductive season may be prolonged, if not year-long.

Of note, 20% of the hatchling or juvenile *P. ateles* at the California Academy of Sciences were striped morphs. The single hatchling from Cocos was unstriped.

### *GEHYRA OCEANICA*

This species is widely distributed on islands in the Pacific Basin (Ineich and Blanc, 1988). However, on Guam, the species is relatively rare and only abundant on Cocos Island. Dense populations are also found in the CNMI (G. Rodda, pers. comm.). Sabath (1981) recorded moderate numbers of *G. oceanica* in several habitats on Guam in 1968 and 1969.

### Length/Weight Relationships.

Analyses of eight specimens, collected from Guam and Cocos Island are presented in Fig. 25.

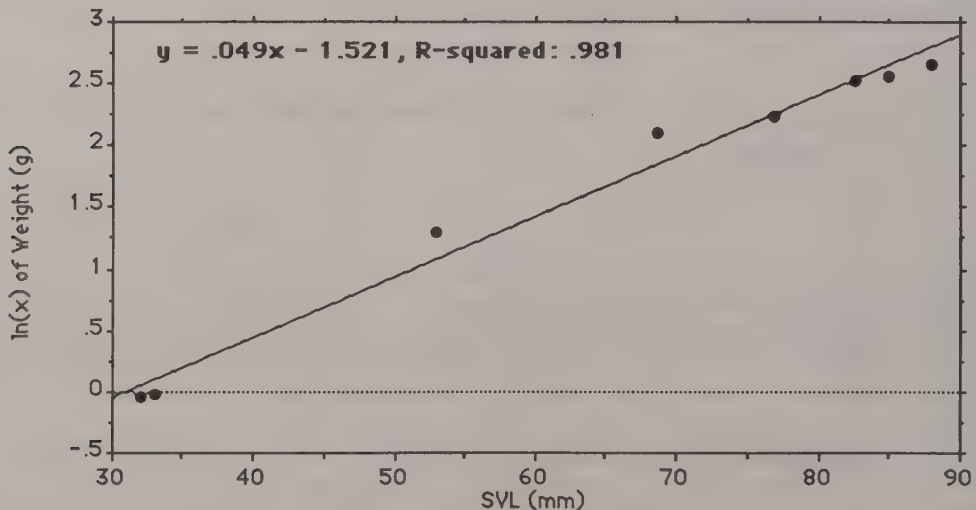


Figure 25. Length versus weight relationship for *G. oceanica*.

## Reproductive Patterns

Males--Little can be discerned from the analyses of reproductive patterns (Fig. 26). All specimens are regarded as mature. Schwaner (1980) was able to document testicular development in Samoan specimens at a smaller size than I. The three smallest specimens in Fig. 25 had not differentiated internally. Reproductive maturity is reached on Guam before 68 mm SVL.

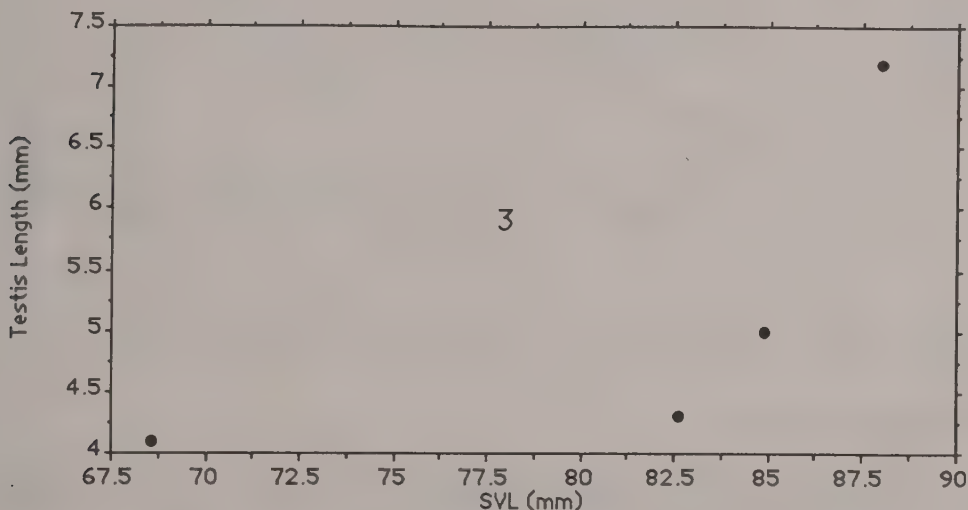


Figure 26. Length versus testes length for *G. oceanica*. Symbols as in Fig. 11.

Females--Even less can be extracted from data on females as only one (76.8 mm SVL) was autopsied. The specimen was mature.

## *GEHYRA MUTILATA*

This species is widely distributed in the Pacific Basin (Ineich and Blanc, 1988) and appears to be relatively common on Guam. This species has been characterized as one of the least homophilic of the gekkonids on Guam.

## Length/Weight Relationships

Analyses of 19 specimens are presented in Fig. 27.

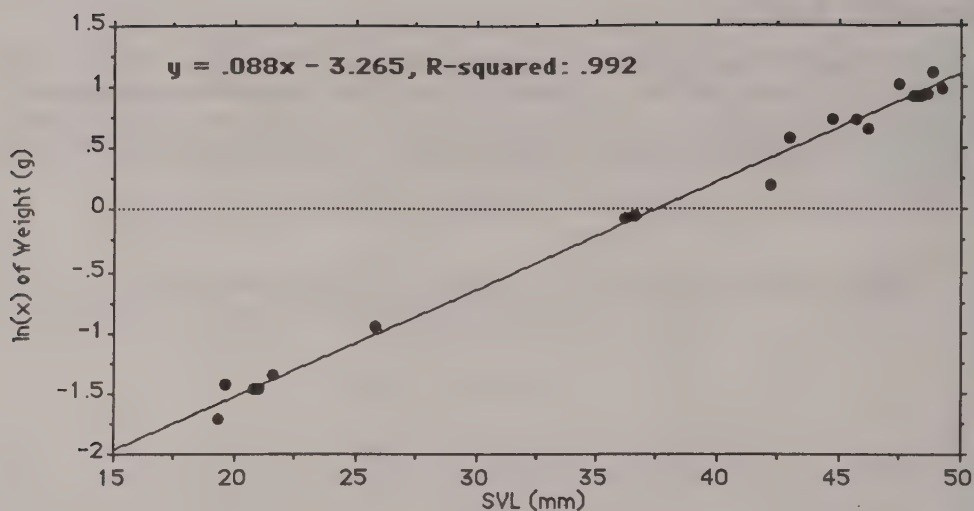


Figure 27. Length versus weight relationship for combined sexes of *G. mutilata*.

### Reproductive Patterns

Males--Reproductive patterns of four specimens are presented in Fig. 28. The level at which maturation occurs is approximately between 36 and 42 mm SVL. Schwaner (1980), based on testes size and development of convoluted tubules, regarded *G. mutilata* as maturing at a SVL greater than 40 mm on American Samoa.

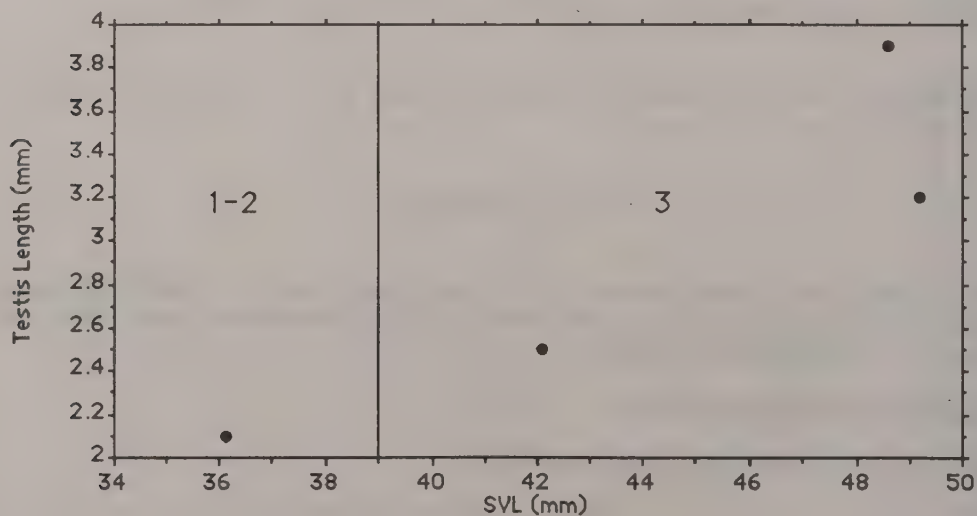


Figure 28. Length versus testis length for *G. mutilata*. Symbols as in Fig. 11.



Females--Reproductive patterns for nine specimens are presented in Fig. 29. Maturity is reached at approximately 44 mm SVL. Schwaner (1980), based on Samoan data, placed reproductive maturity for this species at approximately 40 mm SVL for females. Vitellogenesis is initiated at approximately 2.0 mm diameter.

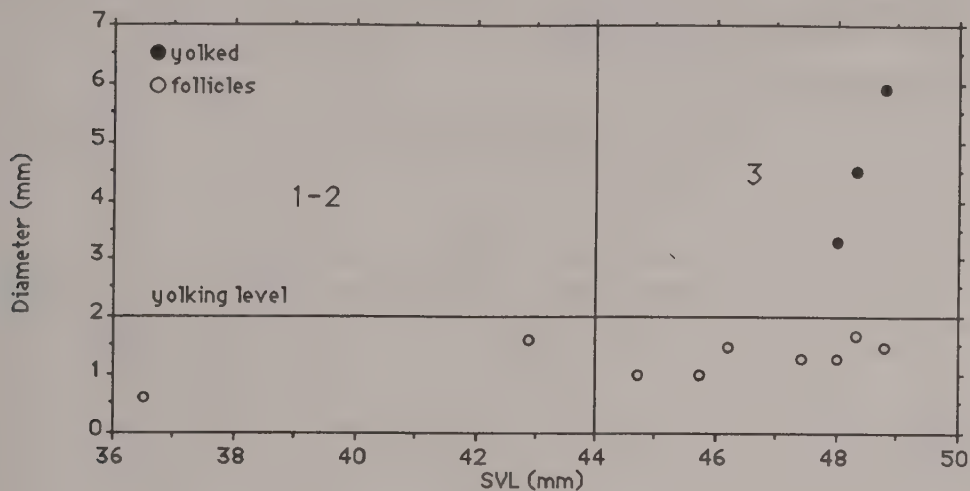


Figure 29. Length versus follicular development for *G. mutilata*. Symbols as in Fig 9.

### Eggs and Hatchlings

Schwaner (1980) specified an invariant clutch size of two for American Samoa. He did find, however, two large females with a single vitellogenic follicle each. One of the Guam females autopsied also contained a single vitellogenic follicle. Thus, average clutch size may be less than two.

Both eggs and hatchlings have been observed or collected from April through September indicating an extended reproductive season or aseasonal reproduction.

Brown and Reyes (1956) reported mean SVL and weights for hatchling *G. mutilata* from the Philippine Islands. Specimens from Guam, with respect to SVL, closely resemble those from the Philippines. However, weights of hatchlings of Guam specimens are considerably less (Philippine range .25 - .37 g, Guam range .18 - .26 g) than those from the Philippines.

### **LEPIDODACTYLUS LUGUBRIS**

This species is one of the most widely distributed vertebrates in the Pacific Basin (Gibbons, 1985; Ineich and Blanc, 1988). Mode of reproduction has been invoked as an explanation for patterns of distribution in reptiles and amphibians in the Pacific and parthenogenesis as the mechanism for certain gekkonids, including *Lepidodactylus*

(Gibbons, 1985). *Lepidodactylus lugubris* is an abundant and conspicuous reptile on Guam and is a parthenoform. This species is very homophilic and is one of the two most commonly encountered geckos.

Recently, investigations uncovered a unisexual/bisexual complex in a portion of the range of this ubiquitous species (Ineich, 1988). A number of morphotypes were characterized and comparison of Guam specimens to these descriptions indicates that Guam specimens most closely resemble Ineich's Clone A.

### Length/Weight Relationships

Data gathered on 19 specimens is presented in Fig. 30.

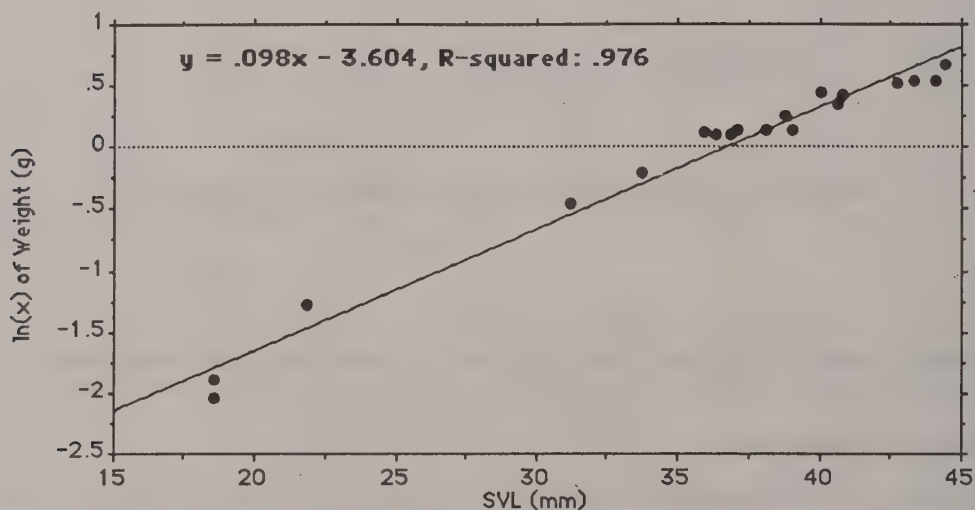


Figure 30. Length versus weight relationship for *L. lugubris*.

### Reproductive Patterns

Although bisexual populations of this species are known from the Hawaiian Islands (Hunsaker and Breese, 1967) and French Polynesia (Ineich, 1988), all specimens examined to date on Guam are females. Reproductive information on 22 specimens is presented in Fig. 31. All specimens less than approximately 39 mm SVL are immature or maturing, while those larger than 39 mm SVL are considered mature. Schwaner (1980) stated that this species matures at sizes greater than 35 mm SVL, although the modal size for fecund (= vitellogenic), ovigerous (= oviductal), and spent (= post oviposition) females was 40 mm SVL. Data on Guam specimens largely agrees with this portrait.

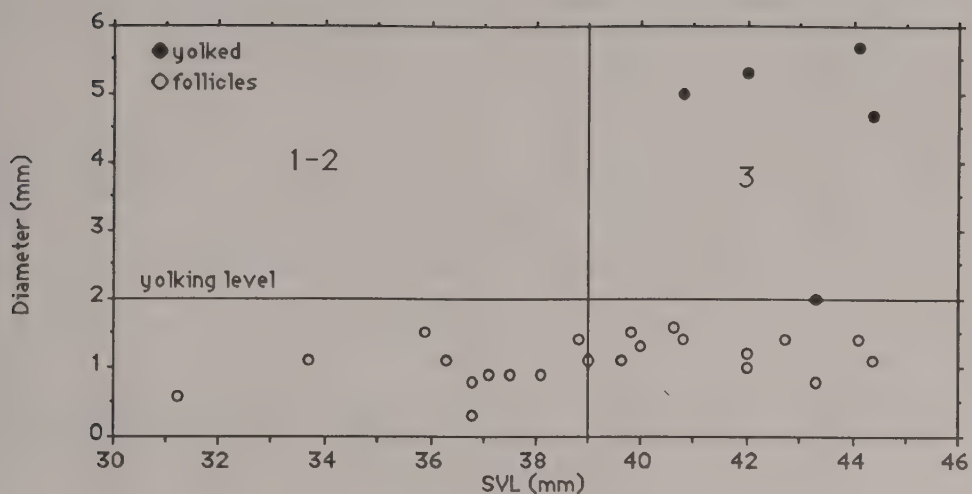


Figure 31. Length versus follicular development for *L. lugubris*. Symbols as in Fig. 9.

Vitellogenesis is initiated at approximately 2.0 mm diameter while shelling of vitellogenic follicles occurs at sizes greater than 5.7 mm diameter. Clutch size is generally regarded as an invariant two (Schwaner, 1980). The largest specimen observed to date on Guam (47.4 mm SVL) contained three clearly visible oviductal eggs. Depending then, on population structure, the average clutch size might be greater than two. An important point is that, by definition, the reproductive output of this species is twice that of a bisexual species because all individuals are female.

### Hatchling Information

Nine hatchlings were obtained from field collected eggs. Relationships of SVL's to weight (Fig. 32) and egg weight (Fig. 33) were poorly correlated ( $R$ -squared = 0.097 and 0.208, respectively). However, of all the species where hatchling data was available, *L. lugubris* hatchlings displayed the highest correlation of weight to egg weight (Fig. 34). This relationship may be fortuitous or it may be a consequence of parthenogenesis where egg size and hatchling weight may be somewhat constrained.

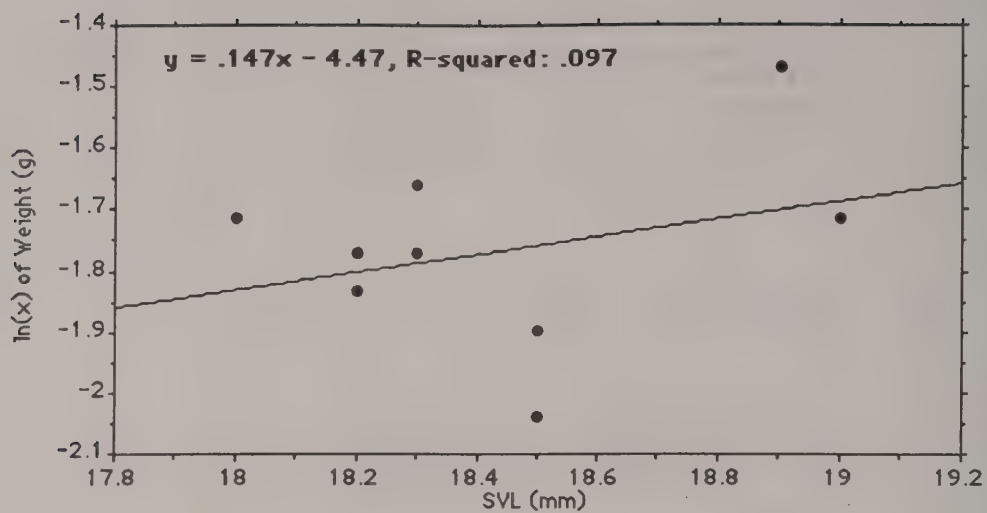


Figure 32. Length versus weight relationship for hatchling *L. lugubris*.

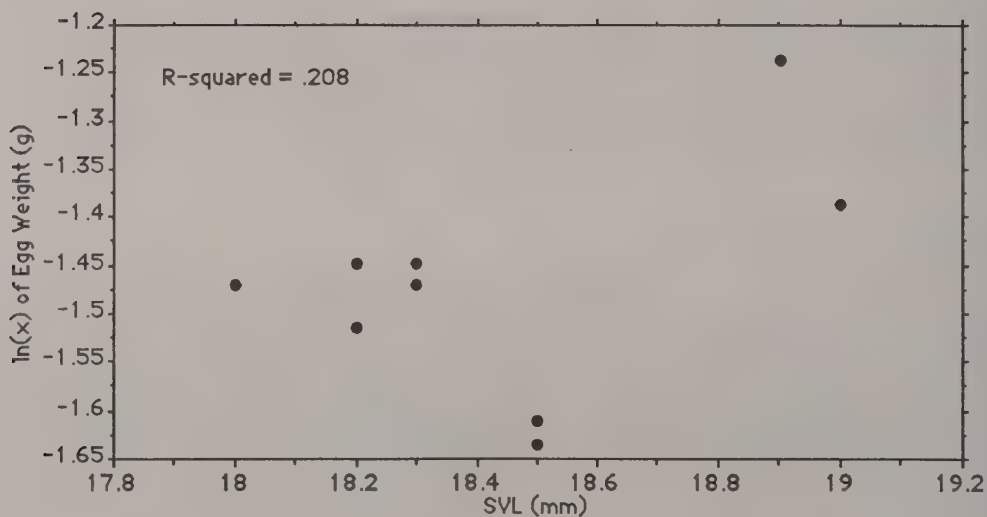


Figure 33. Length versus egg weight relationship for hatchling *L. lugubris*.



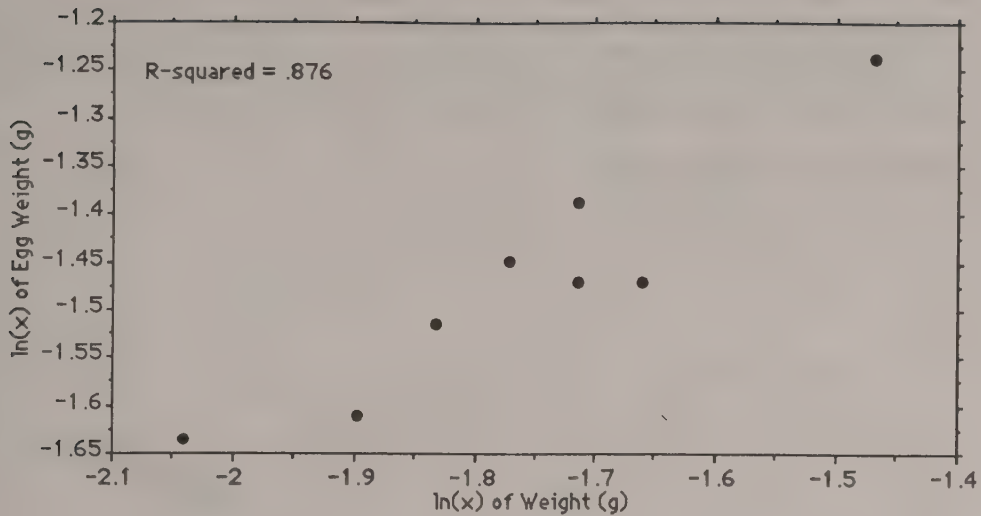


Figure 34. Weight versus egg weight relationship for hatchling *L. lugubris*.

### Marking

A total of 28 *L. lugubris* were marked by either numbering venters or by toe-clipping. Despite that this species is characterized as homophilic, there have been no recaptures of marked animals and they generally disappeared within one day of marking. Presumably, the act of capture alone may have been enough to stimulate emmigration.

### Behavior

Prior to any attempts at marking, considerable time was spent watching interactions between individuals at night. Individuals could be identified by a combination of size and the length of the regenerated portion of the tail. At one study site in Malojloj, on a nightly basis, the same individual (the largest) always gained control of a window pane after one to two hours of interactions with conspecifics. Presumably these interactions were related to resource dominance as the window acted as an insect attractant. Considerable agonistic interactions were observed. Additionally, pseudocopulation was observed on several occasions and photographed once. Werner (1980) reported this phenomenon but was in error as he observed an agonistic interaction. Brown and Sakai (1988) speculated that pseudocopulation might occur but never observed it. Observations of this behavior may be the first documentable record.

## *HEMIDACTYLUS FRENATUS*

This species is also very widely distributed in the Pacific Basin (Gibbons, 1985; Ineich and Blanc, 1988) and there is a mounting body of evidence that suggests that this species may be detrimentally impacting existing gekkonid faunas. McKeown (1978) suggested that *H.*

*frenatus* was displacing *H. garnoti* on the Hawaiian Islands. Gibbons (1985) also suggested that the absence of *H. garnoti* on the Solomon Islands and American Samoa was due to the presence of *H. frenatus*. Thus, the record of *H. garnoti* from Tinian (Cagle, 1946) thought to be a misidentification (Dryden and Taylor, 1969) may be real and the species may have been displaced from the Mariana Islands by *H. frenatus*.

### Length/Weight Relationships

Analyses of 118 specimens is presented in Fig. 35.

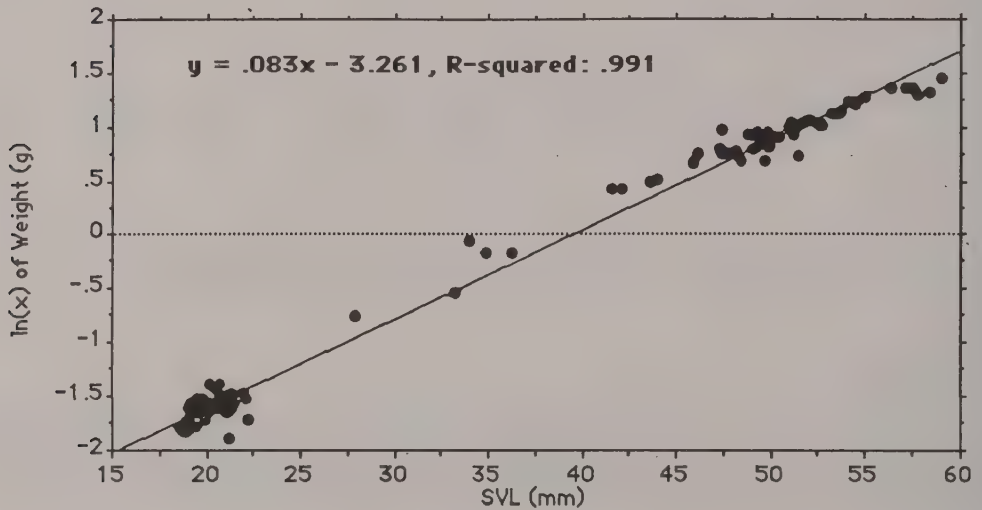


Figure 35. Length versus weight relationship for *H. frenatus*.

### Reproductive Patterns

Males--No Stage One males were collected, but based on 24 specimens, the transition between maturing and mature males was considered to be approximately 45 mm SVL (Fig. 36).

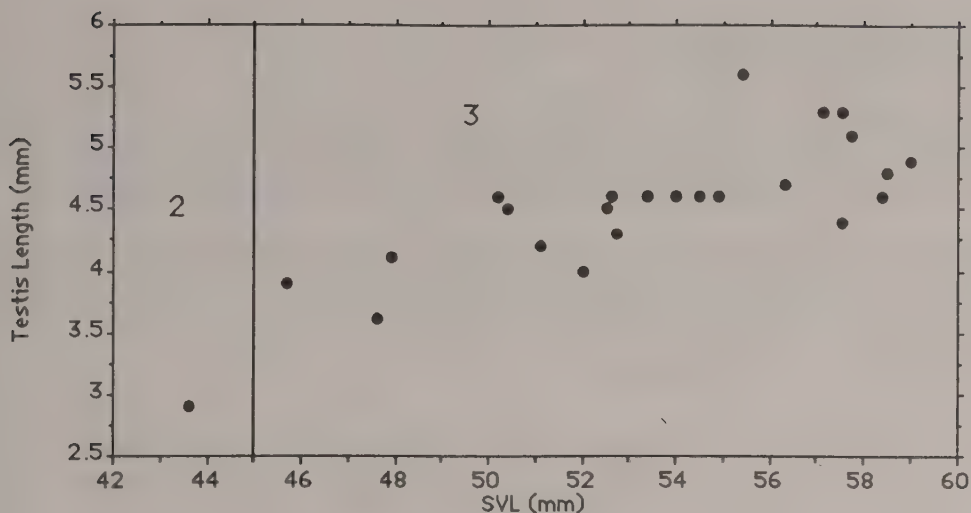


Figure 36. Length versus testis length for *H. frenatus*. Symbols as in Fig. 11.

Females--Analyses of 47 specimens are presented in Fig. 37. Females less than 43 mm SVL are considered immature, between 43 and 47 mm as maturing, and greater than 47 mm SVL as mature. Vitellogenesis appears to be initiated at approximately 1.5 mm diameter and shelling of vitellogenic follicles occurs at greater than 6.6 mm diameter. Clutch size is an invariant two. Schwaner (1980) estimated maturity for both Hawaiian and American Samoa populations as greater than 40 mm SVL. Specimens from Guam are in agreement. Based on field collected eggs and observations of hatchlings, reproduction on Guam is year-long.

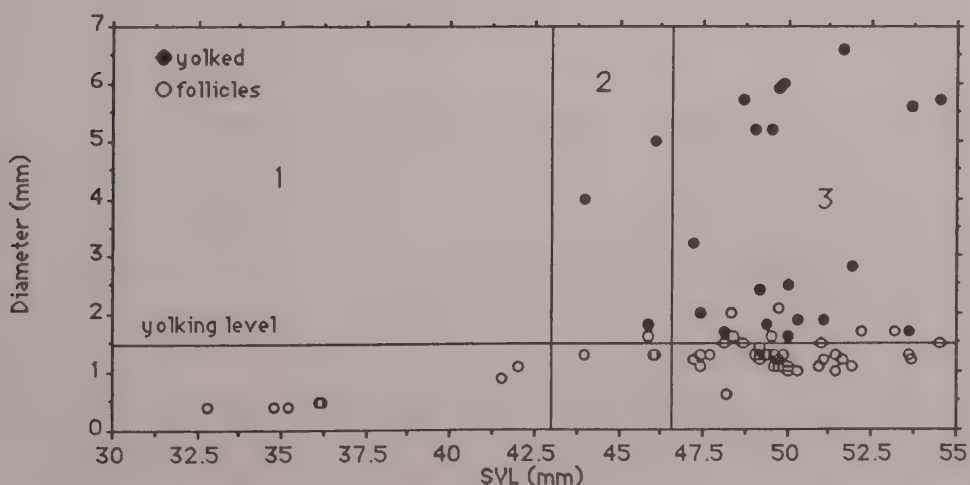


Figure 37. Length versus follicular development for *H. frenatus*. Symbols as in Fig. 9.

### Hatchling Information

Schwaner (1980) reported maximum incubation for this species as between 77 and 88 days. Brown and Alcala (1957) reported incubation as greater than 70 days and Brown and Reyes (1956) reported 71 days. Chou (1979) found a much shorter incubation period of 46 to 58 days. Clutches on Guam hatch in 54 to 57 days (oviposition dates known).

Data on 51 hatchlings obtained from field collected eggs are presented in Figs. 38, 39, and 40. The highest correlation obtained was SVL versus egg weight (Fig. 39). Comparisons of data on egg weights provided by Chou (1979) with field collected eggs from Guam showed general agreement but the range of weights of Guam eggs was greater.

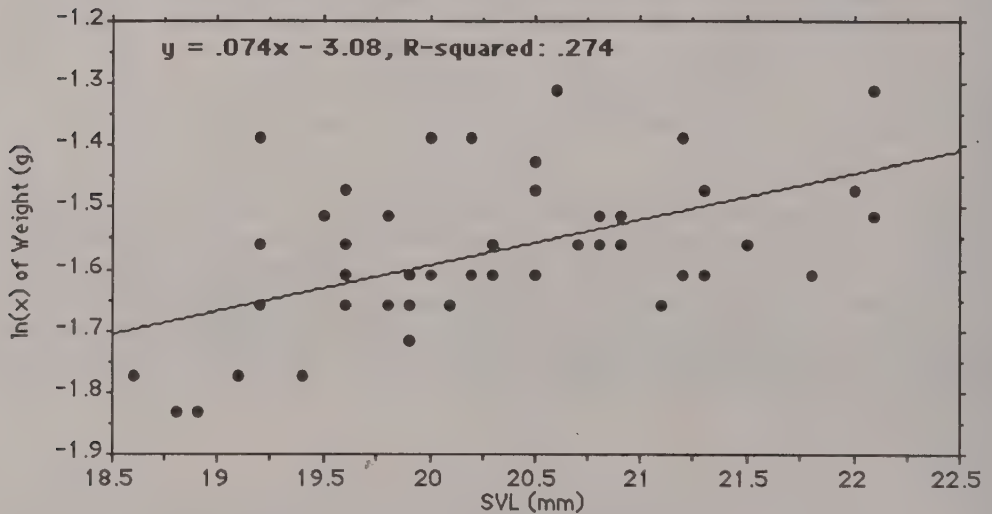


Figure 38. Length versus weight relationship for hatchling *H. frenatus*.



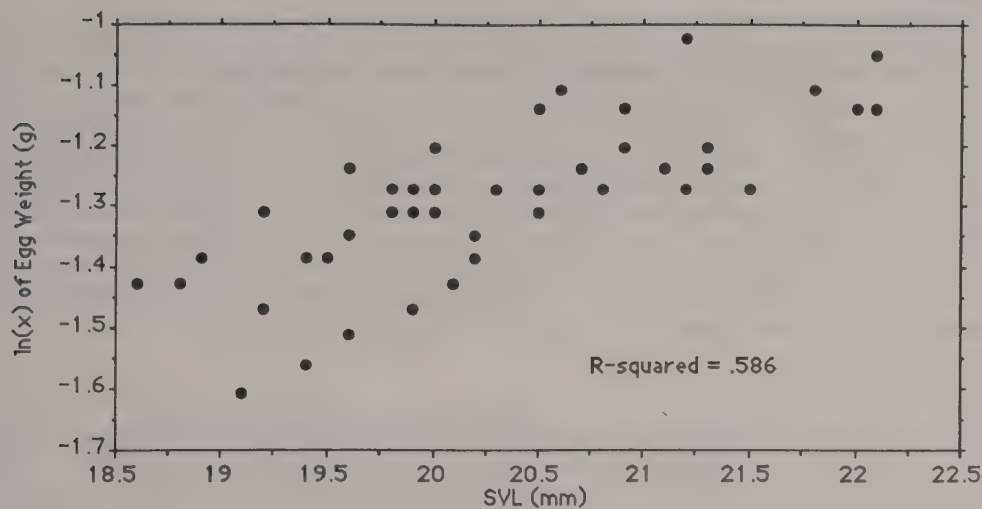


Figure 39. Length versus egg weight relationship of hatchling *H. frenatus*.

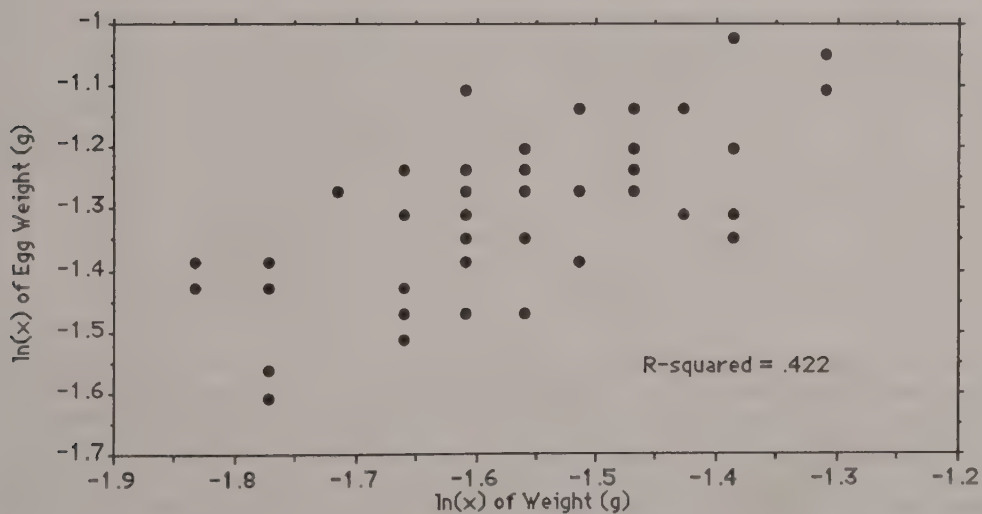


Figure 40. Weight versus egg weight relationship of hatchling *H. frenatus*.

## Marking

A total of 16 *H. frenatus*, neonates and juveniles, were marked by toe-clipping to facilitate permanent individual identification. Of those, eight were recaptured at least once and SVL's recorded (Table 6). Average daily growth was calculated for each individual. The grand average for the species, based on only those individuals that exhibited growth, is 0.135 mm per day (Table 6). The average hatchling SVL was 20.278 mm ( $n = 51$ ) (Fig. 38) and minimum size at maturity is between 45 and 47 mm SVL (Figs. 35 and 36). Using the growth data of marked individuals, the calculated age of individuals recruiting into reproductive maturity would be 183 days (from hatching). While no data are available for growth of adult *H. frenatus*, it is probably safe to assume that growth of juveniles is accelerated in comparison to that of adults. Thus, a slowdown in growth rate might be expected as adult size is approached.

Table 6. Growth of marked *H. frenatus*. The first column is the initial SVL at the time of marking. Days refers to the interval between marking and recapture. Change (mm) refers to difference in SVL from initial marking to recapture. Ave. Growth is Change (mm) divided by Days.

| <u>SVL</u> | <u>Days</u> | <u>Change (mm)</u> | <u>Ave. Growth</u> |
|------------|-------------|--------------------|--------------------|
| 24.7       | 26          | 3.5                | 0.135              |
| 27.9       | 11          | 0                  | 0                  |
| 25.4       | 11          | 0.7                | 0.064              |
| 27.3       | 17          | 3.7                | 0.218              |
| 22.9       | 4           | 0.1                | 0.025              |
| 25.0       | 11          | 2.1                | 0.191              |
| 22.3       | 7           | 0                  | 0                  |
| 28.3       | 55          | 9.7                | 0.176              |

## *ANOLIS CAROLINENSIS*

This species natively occurs in North and Middle America and was presumably introduced sometime prior to 1959. The earliest specimen from Guam housed at the California Academy of Sciences was collected in 1959. Thomas Fritts (pers. comm.) recorded *A. carolinensis* as one of the more abundant food items from stomachs of *B. irregularis* collected at Northwest Field in 1985. Implicit was that *A. carolinensis* was relatively abundant in a non-urban situation. Since 1988, *A. carolinensis* has not been collected from Northwest Field and currently appears to be abundant only in urban situations (M. McCoid, pers. obs.).

## Length/Weight Relationships

A total of six specimens were analyzed and the results are presented in Fig. 41.

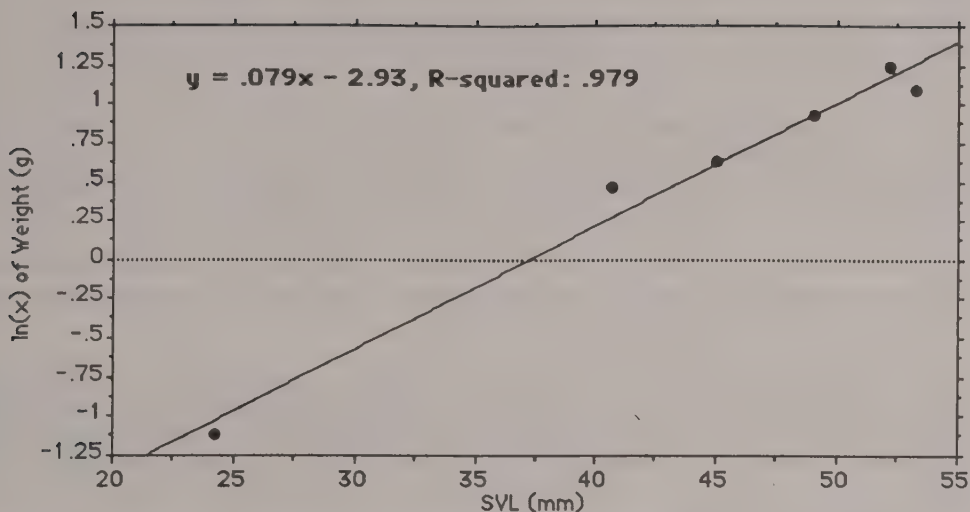


Figure 41. Length versus weight relationship for combined sexes of *A. carolinensis*.

### Reproductive Patterns

**Males**--Only one male was collected and autopsied (45 mm SVL). This individual was considered as maturing.

**Females**--Four females were large enough to be sexed internally (Fig. 42). Females are regarded as mature if larger than 50 mm SVL. Vitellogenesis probably is initiated at approximately 2.0 mm diameter. Interestingly, the 52.1 mm SVL individual possessed oviductal, vitellogenic, and non-vitellogenic eggs simultaneously. Explicit is that this species is capable of producing multiple clutches per year (Vitt, 1986).

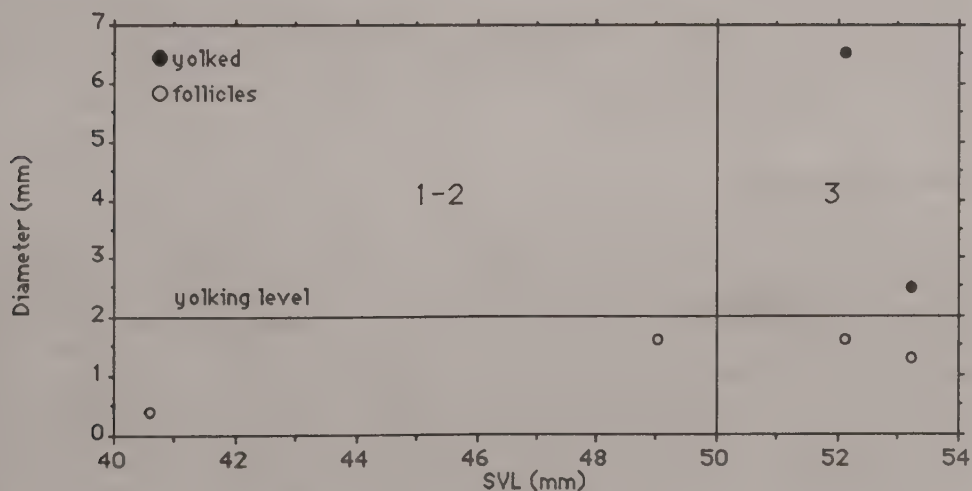


Figure 42. Length versus follicular development for *A. carolinensis*. Symbols as in Fig. 9.

## VARANUS INDICUS

This species is widespread and occurs in northern Australia, New Guinea, and the Solomon and Mariana Islands (Cogger, 1986; Dryden, 1965; McCoy, 1980). Little information was collected during FY '89, however several observations are presented below.

All observations of *V. indicus* occurred at or south of Talofof Bay (see Fig. 5) indicating that populations of this species may be becoming increasingly circumscribed and are relegated to less urbanized areas.

Behavioral observations on a population of large *V. indicus* in Malojloj indicate an heirarchical relationship based, presumably, on size. A single basking site was used by at least five individuals (1.0 - 2.0 m total length) and on cloudless days, the largest individual basked first followed by all others, in order of decreasing size. At no time was more than a single individual basking. On rainy days or at sunset, the smallest individual was generally the only individual to bask.

A juvenile captured on 1 June 1989 (116 mm SVL) measured 121 mm SVL on 12 October 1989 and a captive female oviposited two eggs (40 and 44 mm length) on 20 March 1989. Data on zoo specimens indicates that a clutch size of two is normal (J. Groves, pers. comm.).

## DISCUSSION

A number of species were not addressed in this report because they were not seen or collected. Some of these are the following. *Emoia atrocostata* has been reported on Guam (G. Rodda, pers. comm.) but was only seen on Cocos Island during FY '89. *Emoia slevini* may be extirpated on Guam and apparently now only occurs on Cocos Island and northern islands of the CMNI. *Nactus pelagicus* is probably extinct on Guam and probably occurs in numbers only in the CMNI, although Wiles et al. (1989) failed to record this species on Tinian. This species is probably secretive but has been recently observed on a number of occasions on Rota (G. Wiles and M. Ritter, pers. comm.). *Lipinia noctua* may occur in low numbers or be in habitats not normally collected (forest canopy) on Guam (G. Rodda and G. Wiles, pers. comm.).

### Historical Changes

Sabath (1981) presented a picture of the gekkonid fauna during 1968-69. The twenty year interval to now has shown significant shifts in species' composition on Guam. While habitats surveyed by Sabath may be difficult, if not impossible, to duplicate, some generalizations are possible. Both *G. oceanica* and *P. ateles* were conspicuous members of the herpetofauna of Guam in 1968-69. It appears now that *Perochirus* has apparently been extirpated from Guam and that *G. oceanica* reduced to very low levels. During FY '89, seven specimens of the latter species were recorded or collected (four in Mangilao, one in Malojloj, one in Inarajan (M. Ritter, pers. obs.), and one in Dededo. The only place that both species occur in numbers is Cocos Island (currently snake-free), where *P. ateles* and *G. oceanica* form 4.5 and 6.2% of the gekkonid fauna, respectively. Since these two species are the largest of the gekkonids on Guam and declines in their abundance did not occur until after the proliferation of *B. irregularis*, it is safe to assume the snake was responsible for the demise of both species. These species may have been at risk to



predation by *B. irregularis* for three reasons: they are large, conspicuous and, perhaps, behaviorally less wary than confamilials. Of the gekkonid species on Cocos Island, they are the easiest to hand-collect; and while data are currently sketchy, reproductive output may be comparatively low and growth prolonged to reproductive maturity (as these species are larger).

Declines of both *E. slevini* and *N. pelagicus* are probably unrelated to *Boiga* predation. The last specimens of both species collected on Guam were in 1945. *Emoia slevini* persists on Cocos Island but the status of the population is unknown.

## Interactions

It is difficult to assess the value of population density of prey species in relation to current densities of *Boiga* populations. Studies of *B. irregularis* on Orote Peninsula showed very high population numbers and high gecko (>7 geckos/hour) sightings (G. Rodda, unpubl. data). Studies on the Malojloj grid have shown very low *Boiga* numbers but have also shown, however, the highest observed densities of geckos (8.75 geckos/hour). Dogma dictates that the *Boiga* densities should track densities of prey species with the result being a classic, cyclic predator/prey relationship. Validation or refutation of this hypothesis should be realized with continued efforts on the study grid.

Observations accumulated on the Malojloj study grid have shown differences in habitat selection of two species of geckos. While vegetation characterization of the grid is not yet completed, some trends are evident. *Gehyra mutilata* and *H. frenatus* were observed throughout the grid (Fig. 43), but one overt difference can be discerned. *Pandanus* dominated the flora from B3 through E5 of the grid and *H. frenatus* was essentially absent from this area. All observations of *G. mutilata* from this area were on *Pandanus*. Detailed vegetational analyses may reveal further patterns of habitat partitioning.

*Carlia fusca* has probably greatly impacted *E. caeruleocauda* on Guam. Early observations of the latter species on Guam (Van Denburgh, 1917) listed this species as common and routinely occurring on the ground. On Rota, where *C. fusca* has yet to colonize, *E. caeruleocauda* is abundant and is fairly terrestrial (G. Wiles, pers. comm.). On Guam, *E. caeruleocauda* are semi-arboreal while sympatric *C. fusca* are terrestrial. *Carlia* have been repeatedly observed preying on *Emoia* in non-urban situations while the reverse has not been observed.

## CONCLUSIONS

Since it is becoming increasingly clear that population characteristics of *Boiga* may be reflective of very localized conditions and that these populations may differ significantly, any control or containment procedures instituted must allow for a thorough census to determine size class structure. For example, exclusion or containment techniques for prevention of infestation of other islands should be targeting snakes less than 1.5 m total length. Population structure in local situations should also dictate techniques for amassing data. For example, trapping snakes on the Malojloj grid would indicate the use of lizards as bait while trapping the Malojloj urban site (100 m distant) would dictate the use of avian or mammalian bait (based on mean SVL's and known prey at a given SVL).

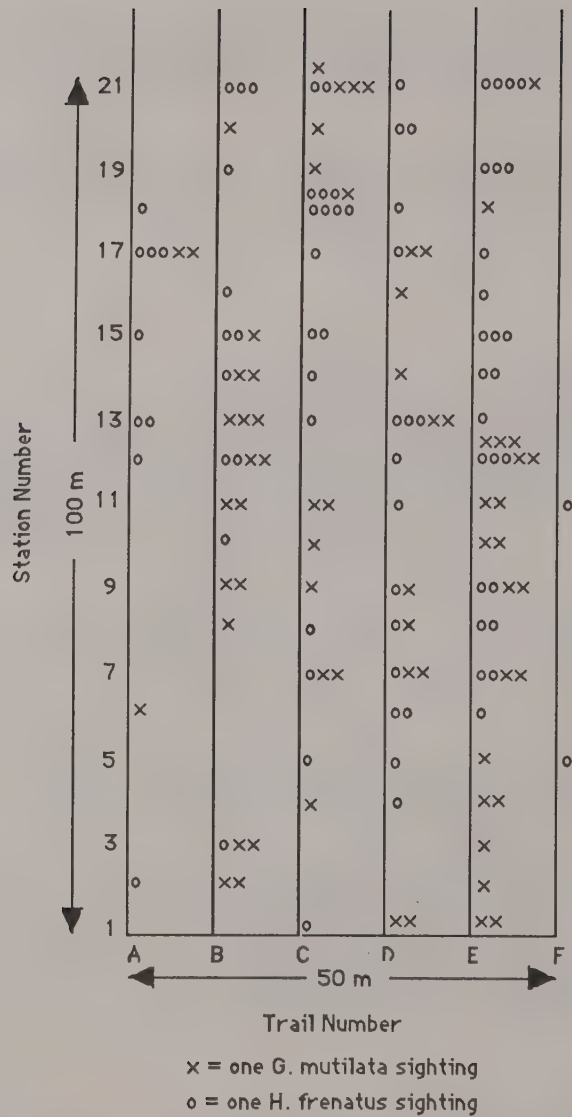


Figure 43. Sightings of the two commonest gekkonids on the Malojloj grid.

Current distribution patterns of prey species remaining on Guam appear to be a synergistic result of the following factors: (1) *B. irregularis* predation, (2) introduced lizards, and (3) as yet unidentified, pre-*Boiga* factors. Unfortunately, despite that homeothermic prey may be essentially absent from major areas on Guam, lizard densities will insure that *Boiga* populations are perpetuated on Guam. Biological profiles of lizard prey species indicate continued high production of potential prey (Table 7).

Table 7. Summary of presumed prey species' reproductive output.

| Species                               | Egg Output |
|---------------------------------------|------------|
| <i>Emoia cyanura</i>                  | high       |
| <i>Emoia slevini</i>                  | ?          |
| <i>Emoia caeruleocauda</i>            | high       |
| <i>Emoia atrocostata</i>              | ?          |
| <i>Lipinia noctua</i>                 | ?          |
| <i>Cryptoblepharus poecilopleurus</i> | low        |
| <i>Carlia fusca</i> *                 | very high  |
| <i>Perochirus ateles</i>              | low        |
| <i>Gehyra oceanica</i>                | low        |
| <i>Gehyra mutilata</i>                | low        |
| <i>Lepidodactylus lugubris</i>        | very high  |
| <i>Hemidactylus frenatus</i> *        | high       |
| <i>Nactus pelagicus</i>               | ?          |
| <i>Anolis carolinensis</i>            | very high  |
| <i>Varanus indicus</i>                | low        |

Generally, those species characterized as 'high' to 'very high' will continue to supply an ample resource base for *B. irregularis*. Species in these categories have multiple clutches, are parthenoforms, or at least two generations per year can recruit to reproductive size. An exception is *A. carolinensis* which is diurnal and arboreal and sleeps up in the vegetation. This scenario probably allowed *B. irregularis* to locally extirpate the species (T. Fritts, pers. comm.) as the snake is an arboreal predator. Those characterized as 'low' have either declined or are currently declining on Guam. Species in this category have an average clutch size of less than two, or are larger, taking longer to recruit to reproductive size. A possible exception is *G. mutilata* which may persist in local pockets of relative abundance. The two species marked with asterisks may be supplying *Boiga* with a food resource but are also negatively impacting sympatric lizard species.

## RECOMMENDATIONS

1. Continue studies of prey species where data are lacking.
2. Continue site specific investigations to characterize *Boiga* populations and the presumed prey base.
3. Initiate site specific control and containment procedures to test the efficacy of such.

4. Initiate captive studies of *Boiga* to garner reproductive data.
5. Initiate growth studies of *Boiga* employing verification and validation techniques.

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Report prepared by: Michael James McCoid.

**JOB PROGRESS REPORT  
RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** E-1-4

**STUDY NO.:** 7

**JOB NO.:** 2

**JOB TITLE:** Movements, Home Range and Activity Patterns of the Brown Tree Snake.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

**SUMMARY**

No significant effort was expended on this job during this segment.

Report Prepared by: Michael James McCoid

## JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-4

STUDY NO.: 7

JOB NO.: 3

**JOB TITLE:** Development and Testing of Control Methods for the Brown Tree Snake.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### SUMMARY

During FY '89, attempts were made to snake proof 7 trees that were being used by Mariana Crows for nesting purposes. Two nests actually hatched eggs. One nest had the chicks predated several days after hatching with the preponderance of evidence indicating monitor lizard predation. The second nest fledged one young, the first successful known fledgling of Mariana Crows on Guam since 1985. Unfortunately, the fledgling was preyed upon after it left the protection of the snake proofed tree. Evidence again points to predation by the monitor lizard as the cause of mortality.

### BACKGROUND

Since the creation in 1960 of the Guam Division of Aquatic and Wildlife Resources (DAWR), census data from roadside counts, station counts, and transect counts have documented the reduction in range and numbers of the Guam Rail, *Rallus owstoni*, and other native birds (DAWR 1961-1987; Jenkins 1979, 1983; Engbring and Ramsey 1984). Most native forest birds are now either extirpated from the wild or restricted primarily to Northwest Field and Conventional Weapons Storage Area (CWA) and surrounding cliffline areas on Andersen Air Force Base (AAFB) in Northern Guam.

Predation by the brown tree snake, *Boiga irregularis*, is believed to be the major factor contributing to recent declines in native bird populations (Savidge 1986, 1987; Conry 1988).

A captive breeding program for the Guam Rail and Guam subspecies of the Micronesian Kingfisher, *Halcyon c. cinnamomina* was successfully begun in 1983 on Guam and at mainland U.S. zoos in cooperation with the American Association of Zoological Parks and Aquariums (DAWR 1984-1986; Derrickson 1986; Shelton 1986).

During the spring and summer of 1985 the DAWR began to experiment with the snake-proofing of both Guam Micronesian Kingfisher and Mariana Crow active nests. Sam Marshall, New York Zoological Society, spent the summer of 1985 on Guam studying the breeding biology of the kingfisher (Marshall in prep). As a part of his study and in cooperation with the DAWR, a single kingfisher nest site was snake-proofed using a 4' galvanized sheet metal sleeve on the trunk of the nest tree. In addition, nearby vegetation was trimmed back to prevent intertree movement of the brown tree snake. A single



kingfisher was successfully fledged and captured from the site and it is now part of the captive breeding program (DAWR 1985).

Gary Michael, Philadelphia Zoological Society, visited Guam during the fall of 1985 and studied the breeding biology of the Mariana Crow, *Corvus kubaryi*, for 3 months (Michael 1986). During that period, DAWR and Michael attempted to snake-proof several crow nest trees. The method used was similar to that mentioned above for the kingfisher and involved encircling the trunk of the nest tree with a 4' long sleeve of galvanized sheet metal 4' to 6' above the ground. In addition, all surrounding vegetation was trimmed so that the brown tree snake could not move through the canopy into the nest tree. No crow nesting attempts observed during this period were successful (DAWR 1985).

During FY '87, DAWR attempted to snake-proof six Mariana Crow nest trees containing actively incubating pairs. All nests failed to hatch young. The cause of the failure could not be positively determined but snake predation was suspected.

During FY '88, a total of 9 Mariana Crow nests were located. Attempts were made to snake-proof only one nest. None of these nests successfully hatched eggs. Two unconfirmed sightings of fledgling crows were reported during the year. Conventional Weapons Storage Area (CWA) and Northwest Field, Anderson Air Force Base remained the center of distribution for crows on Guam.

## OBJECTIVES

To develop methods for protecting roosting and nest sites for endangered native forest birds and fruit bats from predation by the brown tree snake.

## PROCEDURES

1. Locate active Mariana Crow nest sites on Guam.
2. Develop methods for snake-proofing Mariana Crow nest sites.
3. Implement methods for snake-proofing nest sites of Mariana Crow.
4. Consult with herpetologists working on the control of the brown tree snake to develop appropriate methods for snake-proofing crow nest sites.

## RESULTS

During the fiscal year, this project was active on a part time basis only due to limited staff availability. Attempts were made to snake proof 7 Mariana crow nests in Northern Guam at Anderson Air Force Base. One was located on Northwest Field (NWF) and the other 6 were found in adjacent Conventional Weapons Storage Area. Six of the seven nests were in *Elaeocarpus sphaericus* trees with the remaining nest in a *Tristiropsis acutangula* tree. No systematic census of crows on Northern Guam was conducted and the numbers compiled above do not represent relative abundance of crows nesting in each area.

The snake proofing method used was similar to that used in FY '87 and '88 (DAWR 1987, 1988). The surrounding vegetation was trimmed back so snakes could only approach the nest via the main trunk. The main trunk was coated with tanglefoot, a sticky and very thick commercial liquid that has the consistency of heavy oil. The application was applied in a 3' band around the trunk of the tree to inhibit snake movement up the trunk. The tree was visually searched for the presence of snakes from the ground after snake-proofing. In

addition, three snake-proofed nest trees had snake traps placed in the trees to eradicate any snakes present prior to snake-proofing. Observations of trees upon which tanglefoot was applied, indicate that the tanglefoot may be injuring the bark layer which if allowed to continue may damage or kill the tree. We therefore have decided to stop applying tanglefoot pending further evaluation of trees that have already received the treatment.

The first four nests snake-proofed during the year did not successfully hatch eggs. Later in the year, after we began trapping for snakes in the tree after snake-proofing, two actually hatched eggs with a single chick found in each nest. A chick in one of these nests survived for several days, at which time it was apparently taken by a monitor lizard. There was no evidence of any brown tree snakes crossing the tangle-foot barrier. Four snakes were trapped out of this tree before the eggs were hatched. The second nest successfully fledged a young crow. This was the first known successful reproduction of the Mariana Crow on Guam since 1985. Unfortunately, several days after the fledgling left the protected nest tree, it was found dead on the forest floor apparently the victim of predation by monitor lizards. One of the parents was found injured nearby and brought into the DAWR facility for rehabilitation.

Field observations made while searching for crow nests indicate that the CWA and Northwest Field, both on Anderson Air Force Base, are the center of distribution for approximately 50 crows still remaining on Guam.

## RECOMMENDATIONS

1. Continue efforts to locate active Mariana Crow nest sites. This should be combined with field studies of the ecology and breeding biology of the Mariana Crow both on Guam and Rota.
2. Continue to predator-proof active Mariana Crow nest sites on Guam.
3. Develop and test new methods for snake-proofing crow nest trees. This would be accomplished by setting up an experimental facility on Guam to test snake and monitor lizard barriers under controlled laboratory conditions for use in preventing predation of crow nests in the field on Guam.
4. Consult with herpetologists working on the control of the brown tree snake to develop appropriate methods for snake-proofing crow nest sites.

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Report prepared by: Robert E. Beck, Jr.

## **JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** E-1-4

**STUDY NO.:** 8

**JOB NO.:** 1

**JOB TITLE:** Moorhen Recovery and Management.

**PERIOD COVERED:** October 1, 1988 to September 30, 1989

### **SUMMARY**

During FY '89 an island-wide wetland survey/moorhen distribution study was undertaken. Most of the wetlands were surveyed twice; once during the wet season (Oct.-Dec. 1988) and again during the dry season (Apr.-May 1989). Each wetland was identified as man-made or natural, the vegetation was identified and ultimately classified as dominate or subordinate, the percent of open water approximated and any signs of moorhen recorded.. This survey found that moorhen utilized both persistent and seasonal as well as man-made and natural wetlands. During the wet season, 44 wetlands were surveyed and moorhen were recorded at 18 (42%) of these. During the dry season, 36 wetlands were surveyed and moorhen were recorded at 14 (36%) of these.

### **BACKGROUND**

The Mariana Common Moorhen (*Gallinula chloropus guami*) is listed both locally and federally as an endangered species. It is endemic to the Mariana Islands and is found only on the islands of Guam, Tinian and Saipan. Since the inception of the Division of Aquatic and Wildlife Resources in 1960, the study of the moorhen has been limited and sporadic because of budget and manpower constraints. Early work centered on monthly surveys at Fena Valley Reservoir and periodic visits to some wetlands. From 1963-1968, 54 monthly counts were conducted at this reservoir with an average of 6.7 birds recorded per count. These counts showed an increase in moorhen numbers during the dry season and a decrease during the wet season. During the 1970's, more research was done and Drahos (1977) provided the first population estimate of 150 moorhen for the island of Guam. As recently as 1979, the moorhen population was estimated at less than 100 birds (Tenorio & Associates 1979). Monthly counts at Fena Valley Reservoir since April 1987 have averaged 32.4 birds/count and have shown that moorhen numbers typically increase during the dry season and decrease during the wet season. Recent research indicates that the moorhen population on Guam has been relatively stable over the last several years and is currently estimated at 100-125 birds.

### **OBJECTIVES**

To inventory the wetlands of Guam and to determine the distribution of moorhen on Guam as an initial step as called for in the Mariana Moorhen Recovery Plan.



## PROCEDURES

1. To survey and inventory wetlands to record their present condition and seasonal availability to moorhen.
2. To determine the present distribution and population level of moorhen on Guam.
3. Develop a database of wetland types and general characteristics for wetlands inhabited by moorhen.

## RESULTS

### Wetlands, Moorhen Distribution, Wetland Utilization

As an initial step in the Moorhen Recovery Plan, an island-wide wetland/moorhen distribution survey was done in FY'89. Two surveys were done; one during the wet season (Oct.-Dec. 1988) and the other during the dry season (April-May 1989). Thirty-seven wetland sites totalling 44 individual wetlands were surveyed during the wet season and 30 wetlands sites totalling 36 individual wetlands were surveyed during the dry season (Fig.1). Wetland sites 38, 39 and 40 were first surveyed during the dry season. The majority of the information on wetland characteristics was collected during the wet season survey. The dry season survey was done to document changes in vegetation, water level and utilization by moorhen. At each wetland, its approximate size, approximate percent of open water (where no emergent vegetation occurs), dominant wetland plant(s), subordinate wetland plant(s) and wetland classification were recorded and summarized in Tables 1 and 2. Extensive use of the Guam National Wetlands Inventory Maps was used to locate wetlands and confirm wetland classifications. Some wetlands surveyed were not on the map and were classified in accordance with Classification of Wetlands and Deep-Water Habitats of the United States, Cowardin, et al, 1977.

During the wet season, 44 wetlands encompassing approximately 302.6 hectares were surveyed. Moorhen were recorded at 18 of these wetlands which totaled approximately 150 ha, or 50% of wetlands surveyed during the wet season. During the dry season, 36 wetlands totalling approximately 231.8 hectares were surveyed. Moorhen were recorded at 14 of these wetlands which totaled approximately 155.6 ha, or 67% of the wetland areas surveyed during the dry season (Table 1, Fig. 1). Wetland sites 19-25 have previously been utilized by moorhen in recent and historical times but no moorhen were recorded at them during either survey (Fig. 1). Characteristics of these wetlands are summarized in Table 2.

Man-made wetlands were important resources for moorhen. Eighty-three percent (15) of the wetlands used during the wet season and 77% of those used during the dry season were man-made (Table 1). The size of the wetlands utilized by moorhen during this survey, excluding Fena Valley Reservoir (81 ha) and Agana Swamp (71 ha), averaged 0.7 ha with the majority of wetlands (11), 0.6 ha in size or smaller. The approximate percent of open water, where no emergent vegetation occurs, at the wetlands utilized by moorhen ranged from 0%-95% with an average of 55% open water. Wetlands utilized by moorhen were predominantly vegetated by nonpersistent emergents or aquatic bed plant species.

## RECOMMENDATIONS

1. Continue to survey Fena Valley Reservoir on a monthly basis.

2. Expand wetland survey and database to include those wetlands which were not a part of the present survey.
3. Continue to survey the wetlands done in this survey to document seasonal availability, vegetative changes and moorhen utilization.

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Report prepared by: Michael W. Ritter

**Table 1.** Summary of key characteristics for wetlands used by moorhen during the wet and dry seasons. Wetland site numbers correspond to those used on Figure 1.

| Wetland site         | Approx. Size(ha) | Approx. % Openwater | Dominant Plant         | Subordinate Plant     | Wetland Classification | Man-Made Natural | Moorhen use Wet-Dry Season |
|----------------------|------------------|---------------------|------------------------|-----------------------|------------------------|------------------|----------------------------|
| 1-Barrigada pond     | <.5              | 75%                 | <i>Spirodela</i> sp.   | <i>P. muticum</i>     | PAB4/OWHh              | man-made         | W-D                        |
| 2-Prison pond        | <.5              | 95%                 | <i>I. aquatica</i>     | <i>P. muticum</i>     | POWHh                  | man-made         | W-D                        |
| 3-GSI upper          | <.5              | 50%                 | <i>H. verticillata</i> | <i>P. karka</i>       | PAB2/OWHh              | man-made         | W-D                        |
| 4-GSI lower          | .5               | 95%                 | <i>P. muticum</i>      | <i>P. karka</i>       | POWKH                  | man-made         | W-D                        |
| 5-GSI west           | .8               | 50%                 | <i>Cyperus</i> spp.    | <i>Cyperus</i> spp.   | POWKx/EM1F             | man-made         | W-D                        |
| 6-GSI diked fields   | <.5              | 50%                 | <i>Paspalum</i> spp.   | <i>Cyperus</i> spp.   | PEM2C                  | man-made         | W-D                        |
| 7-Fena Reservoir     | 81               | 95%                 | <i>H. verticillata</i> | <i>P. muticum</i>     | L1OWHh                 | man-made         | W-D                        |
| 8-Agana Swamp        | 71               | <25%                | <i>P. karka</i>        | <i>Cyperus</i> spp.   | PEM1H                  | natural          | W-D                        |
| 9-Assupian pond      | .5               | 50%                 | <i>Paspalum</i> spp.   | <i>Cyperus</i> spp.   | POWF/EM1Fh             | man-made         | W                          |
| 10-Y abai wetland    | 1.2              | 25%                 | <i>Paspalum</i> spp.   | <i>E. crassipes</i>   | PEM1Fh                 | man-made         | W-D                        |
| 11-NavMag pond       | .5               | 50%                 | unknown algæ           | <i>P. karka</i>       | PAB1/EM1Hh             | man-made         | W                          |
| 12-NavMag Swamp 1    | .6               | 50%                 | <i>P. marianensis</i>  | <i>P. Karka</i>       | PAB2/EM1F              | natural          | W-D                        |
| 13-NavMag Swamp 2    | 1.6              | 30%                 | <i>P. karka</i>        | <i>P. marianensis</i> | PAB2/EM1F              | natural          | W-D                        |
| 14-Pulantat west     | 1.2              | 50%                 | <i>E. ochrosachys</i>  | <i>E. dulcis</i>      | PEM1F                  | man-made         | W                          |
| 15-County Club #3    | <.5              | 0%                  | <i>I. aquatica</i>     | <i>P. muticum</i>     | PEM1Fh                 | man-made         | W-D                        |
| 16-Sarasa pond       | 1.2              | 75%                 | <i>E. ochrosachys</i>  | <i>P. karka</i>       | POW/EM1Hh              | man-made         | W                          |
| 17-Masso Reservoir   | 1.6              | 75%                 | <i>P. karka</i>        | <i>H. difformis</i>   | PAB2/OWHh              | man-made         | W-D                        |
| 18-Tumon Bay pothole | .2               | 75%                 | <i>H. verticillata</i> | <i>P. muticum</i>     | PAB2Hh                 | man-made         | W-D                        |
| 39-Acapulco*         | .8               | 50%                 | <i>Cyperus</i> spp.    | <i>Panicum</i> spp.   | POW/EM1F               | natural          | D                          |

\* Wetland No.39 was only surveyed during the dry season.

**Table 2.** Summary of key wetland characteristics for wetlands where moorhen were not recorded during either wet or dry season surveys. Wetland site numbers correspond to those used on Figure 1.

| Wetland site         | Approx. Size(ha) | Approx. % Openwater | Dominant Plant         | Subordinate Plant      | Man-Made Natural | Wetland Classification |
|----------------------|------------------|---------------------|------------------------|------------------------|------------------|------------------------|
| 19-Marianas Terrace  | 1.2              | 0%                  | <i>P. karka</i>        | <i>P. muticum</i>      | man-made         | PEM1F                  |
| 20-DOA wetland       | 1.4              | 5%                  | <i>P. muticum</i>      |                        | natural          | PEM1F                  |
| 21-Sumay north       | .6               | 25%                 | <i>P. indica</i>       | <i>C. ligularis</i>    | ?                | E2EM1N-E2FL2N          |
| Sumay south          | .6               | 5%                  | <i>S. lioralis</i>     |                        | ?                | PSS3/EM1F              |
| 22-NavSta wetland    | 40               | 5%                  | <i>P. karka</i>        | <i>P. muticum</i>      | natural          | PEM1F                  |
| 23-Fish ponds        | 6                | 95%                 | <i>P. muticum</i>      |                        | man-made         | POWKHx                 |
| Fish ponds           | 8                | 95%                 | <i>P. muticum</i>      |                        | man-made         | POWKHx                 |
| Fish ponds           | 6                | 95%                 | <i>P. muticum</i>      |                        | man-made         | POWKHx                 |
| 24-Toguan Sewage     | .5               | 75%                 | <i>Spirodela</i>       |                        | man-made         | POWKHr                 |
| 25-Pulantal east     | .8               | 30%                 | <i>E. ochrostachys</i> | <i>P. muticum</i>      | man-made         | PEM1Fh                 |
| 26-Atantano          | 72               | 5%                  | <i>P. karka</i>        | <i>P. muticum</i>      | natural          | PEM1H                  |
| 27-San Luis west     | .5               | 10%                 | <i>S. lioralis</i>     |                        | man-made         | POWHh-PEM1Ch           |
| San Luis east        | 1.6              | 50%                 | <i>S. lioralis</i>     |                        | man-made         | L1OWHh-PEM1H           |
| 28-N. Tipalao marsh  | 1.2              | 0%                  | <i>C. interruptus</i>  | <i>A. aureum</i>       | natural          | PEM1H                  |
| 29-Mapoa             | .8               | 20%                 | <i>P. karka</i>        |                        | natural          | POW/EM1F               |
| 30-Cowboy camp       | .8               | 90%                 | <i>Paspalum</i> spp.   |                        | natural          | POWH                   |
| 31-Windmill ponds    | .2               | 50%                 | <i>Paspalum</i> spp.   | <i>Cyperus</i> spp.    | man-made         | PEM1FK                 |
| 32-S. Windmill pond  | .5               | 50%                 | <i>P. karka</i>        | <i>Cyperus</i> spp.    | man-made         | PEM1F                  |
| 33-T. Falls wetlands | .4               | 10%                 | <i>E. ochrostachys</i> | <i>Cyperus</i> spp.    | natural          | PEM1C                  |
| 34-Layon             | .4               | 5%                  | <i>Paspalum</i> spp.   | <i>Cyperus</i> spp.    | natural          | PEM1F                  |
| 35-Fensol            | .8               | 10%                 | <i>E. ochrostachys</i> | <i>Cyperus</i> spp.    | natural          | PEM1F                  |
| 36-Nagan 1           | .4               | 15%                 | <i>P. karka</i>        | <i>E. ochrostachys</i> | natural          | PEM1F                  |
| 37-Nagan 2           | .4               | 100%                |                        |                        | man-made         | POWHh                  |
| 38-Tinechong         | .4               | 50%                 | <i>Paspalum</i> spp.   | <i>P. karka</i>        | man-made         | POW/EM1F               |
| 40-Baringtonia       | .4               | 0%                  | <i>Baringtonia</i> sp. | <i>Spirodela</i> sp.   | natural          | PFO3/AB4F              |



# APPENDIX A

## Locations of Wetlands

| Wetland site               | USGS map    | Approx. coordinates* |
|----------------------------|-------------|----------------------|
| 1- Barrigada ponding basin | Agana       | 90 x 61.5            |
| 2- Prison ponding basin    | Agana       | 88 x 60              |
| 3- GSI upper               | Agat        | 84.5 x 49.5          |
| 4- GSI lower               | Agat        | 84.5 x 49            |
| 5- GSI west                | Agat        | 85 x 49              |
| 6- GSI diked fields        | Agat        | 84.5 x 49.5          |
| 7- Fena Reservoir          | Agat        | 78 x 51              |
| 8- Agana Swamp             | Agana       | 90 x 56.5            |
| 9- Assupian                | Talofof     | 72 x 56              |
| 10- Yabai wetland          | Inarajan    | 70 x 56              |
| 11- NavMag pond            | Agat        | 81 x 48.5            |
| 12- NavMag Swamp 1         | Talofof     | 79 x 52.5            |
| 13- NavMag Swamp 2         | Talofof     | 79 x 52.5            |
| 14- Pulantat west          | Agana       | 85 x 54              |
| 15- Country Club #3        | Talofof     | 79 x 57              |
| 16- Sarasa pond            | Talofof     | 75 x 53              |
| 17- Masso Reservoir        | Apra Harbor | 89 x 50              |
| 18- Tumon Bay pothole      | Dededo      | 95 x 62              |
| 19- Marianas Terrace       | Dededo      | 97 x 66              |
| 20- DOA wetland            | Agana       | 88 x 61              |
| 21- Sumay north            | Apra Harbor | 87 x 46              |
| Sumay south                | Apra Harbor | 87 x 46              |
| 22- NavSta wetland         | Apra Harbor | 84 x 47              |
| 23- Talofof Fish ponds     | Talofof     | 76 x 57              |
| Inarajan Fish ponds        | Inarajan    | 68 x 54              |
| Ija Fish ponds             | Inarajan    | 66 x 52              |
| 24- Toguan Sewage          | Merizo      | 70 x 46              |
| 25- Pulantat east          | Agana       | 85 x 55              |
| 26- Atantano               | Agat        | 84 x 48              |
| 27- San Luis west          | Apra Harbor | 87 x 47              |
| San Luis east              | Apra Harbor | 87 x 47              |
| 28- N.Tipalao marsh        | Apra Harbor | 85 x 45              |
| 29- Mapoa                  | Talofof     | 77 x 54              |
| 30- Cowboy camp            | Talofof     | 75 x 52              |
| 31- Windmill ponds         | Talofof     | 75 x 52              |
| 32- S.Windmill pond        | Talofof     | 74 x 53              |
| 33- T.Falls wetlands       | Talofof     | 73 x 55              |
| 34- Layon                  | Talofof     | 72 x 53              |
| 35- Fensol                 | Talofof     | 71 x 54              |
| 36- Nagan 1                | Inarajan    | 69 x 53              |
| 37- Nagan 2                | Inarajan    | 69 x 52              |
| 38- Tinechong              | Talofof     | 76 x 52              |
| 39- Acapulco               | Talofof     | 76 x 55              |
| 40- Barringtonia           | Talofof     | 76 x 57              |

\* Based on 1000-meter Universal Transverse Mercator grid tcks.

**APPENDIX B**  
**Scientific Names of Plants from Tables 1 & 2**

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*Cyperus ligularis*  
*Eichhornia crassipes*  
*Eleocharis dulcus*  
*Eleocharis ochrostachys*  
*Hydrilla verticillata*  
*Hygrophila difformis*  
*Ipomoea aquatica*  
*Panicum muticum*  
*Phragmites karka*  
*Pluchea indica*  
*Potamogeton marianensis*  
*Scirpus litoralis*

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**LAW ENFORCEMENT**  
**Funding Source: Government of Guam**





## LAW ENFORCEMENT SECTION

During FY '89, a total of 30 persons were arrested and charged with violating fish and game laws. Of the 30 individuals arrested, 21 were charged for illegal hunting. At the end of the reporting period, only 2 had pleaded guilty and the rest were still awaiting prosecution. Of the 9 individuals arrested and charged with illegal fishing, only one had pleaded guilty by the end of the reporting period. These 9 illegal fishermen included one male juvenile, age 16. The juvenile authorities and Guam Police Department (GPD) were contacted and the minor was instructed by letter, to have his guardian accompany him to the Youth Division at GPD to answer the charges against him. Also, a report was submitted to the Attorney General's Prosecutor's Office for their information and disposition.

In addition, an adult male, formerly from Korea, was charged with commercializing trochus shells without a permit. He was formally charged, booked and released. Two thousand pounds of trochus shells of various sizes were confiscated at the Guam Port Authority Pier where he was intercepted by Customs and Quarantine Officers.

Furthermore, three vehicles were confiscated as evidence from individuals charged with transporting deer carcasses illegally. Forfeiture actions were filed against these vehicles and only one was legally forfeited to the Department of Agriculture for its disposition. The other two were released back to the owners with stipulating conditions through plea bargains. The first vehicle was a 1989 Mazda pickup truck owned by a defendant who had entered a plea of nolo contendere to the offense of illegal hunting. In exchange, the Government moved to dismiss the charge of forfeiture and the court granted the motion. The court further found to its satisfaction, that there was a factual basis for the plea and the court then accepted the defendant's plea and based on his plea, a judgement was entered. It was ordered and adjudged by the court that the defendant pay a fine of One Thousand Dollars (\$1,000.00) plus court costs with the said fine to be payable to the Department of Agriculture's Conservation Fund.

The second vehicle, a 1986 Toyota pickup truck owned by Hatsuho International, Inc., which operates the Hatsuho Golf Course was confiscated because it was used by three Hatsuho Golf Course employees as an instrument in killing a deer. The three were also arrested for alleged killing of the deer. On September 15, 1989, the Attorney General of Guam received a petition for mitigation of the forfeiture of the vehicle owned by petitioner Hatsuho International, Inc. The petitioner agreed that their vehicle had been used in the illegal taking of wild game but stated that at no time did they have any knowledge or reason to believe that the vehicle would be used in violation of the law. The court ruled that there were extenuating circumstances indicating that relief should be granted to avoid extreme hardship and that the truck could be returned provided the petitioner pays a penalty of Two Thousand Dollars (\$2,000.00) to the Conservation Fund of the Division of Aquatic and Wildlife Resources, Department of Agriculture and execute of release of liability.

On May 24, 1989, Guam Environmental Protection Agency (GEPA) employees reported that they had discovered an illegal fish kill in the Cetti Bay area. Our officers responded to the report and met with GEPA personnel at Umatac Bay where they boarded the GEPA's boat. Subsequently, upon their arrival at the Cetti Bay location, they confronted the responsible individuals. A total of five adults and one minor, all males, were taken into custody, arrested and charged for violation of 5 Guam Code Annotated, Section 12308.1 which prohibits wanton waste of fish caught, and 5 GCA, Section 12311.1 which prohibits nets from being left unattended for more than 6 hours. As a result of this arrest, a 20 ft. boat with an outboard engine, a jet ski, and an undetermined length of deep water



fish net were confiscated. A forfeiture action was filed against these items and was still pending at the end of the period.

In addition, as ordered by the court, several weapons and other hunting paraphernalia from 1987/88 cases were forfeited to the Department for its disposition.

Numerous incidents such as turtle hunting, fish dynamiting, fish poisoning and spotlighting were investigated by Conservation Officers but did not result in arrest. Frequently, by the time the Conservation Officers arrived at the scene to investigate, the responsible person(s) would no longer be in the area. In some cases, suspects were apprehended but not arrested because of insufficient evidence and warnings were issued. Field investigation reports of such incidents were submitted and filed for future reference.

In June of 1989, two Conservation Officers attended a Federal Fish and Wildlife Covert Investigations Seminar at the Federal Law Enforcement Training Center at Glynco, Georgia. The education and experience were good for the officers for it provided the opportunity to learn advanced methods and techniques in Law Enforcement which they can share with other officers. It is recommended that other officers be given the opportunity to attend future seminars such as this.

In July of 1989, three of our new recruit Conservation Officers completed their vigorous training and graduated from the Guam Criminal Justice at Guam Community College. One of them received a certificate and trophy in recognition of his achievement as the best pistol shooter among all other recruits including police officers (also known as the Top Gun)

At the end of the reporting period the Law Enforcement Section was operating at full force with a total of eight officers. With this complement, the Law Enforcement Section will be divided into two units, monitoring both night and day fishing and hunting activities.

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